Domestic Robots

Frances Ashmore

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Chapter- 1

Introduction to Domestic Robot

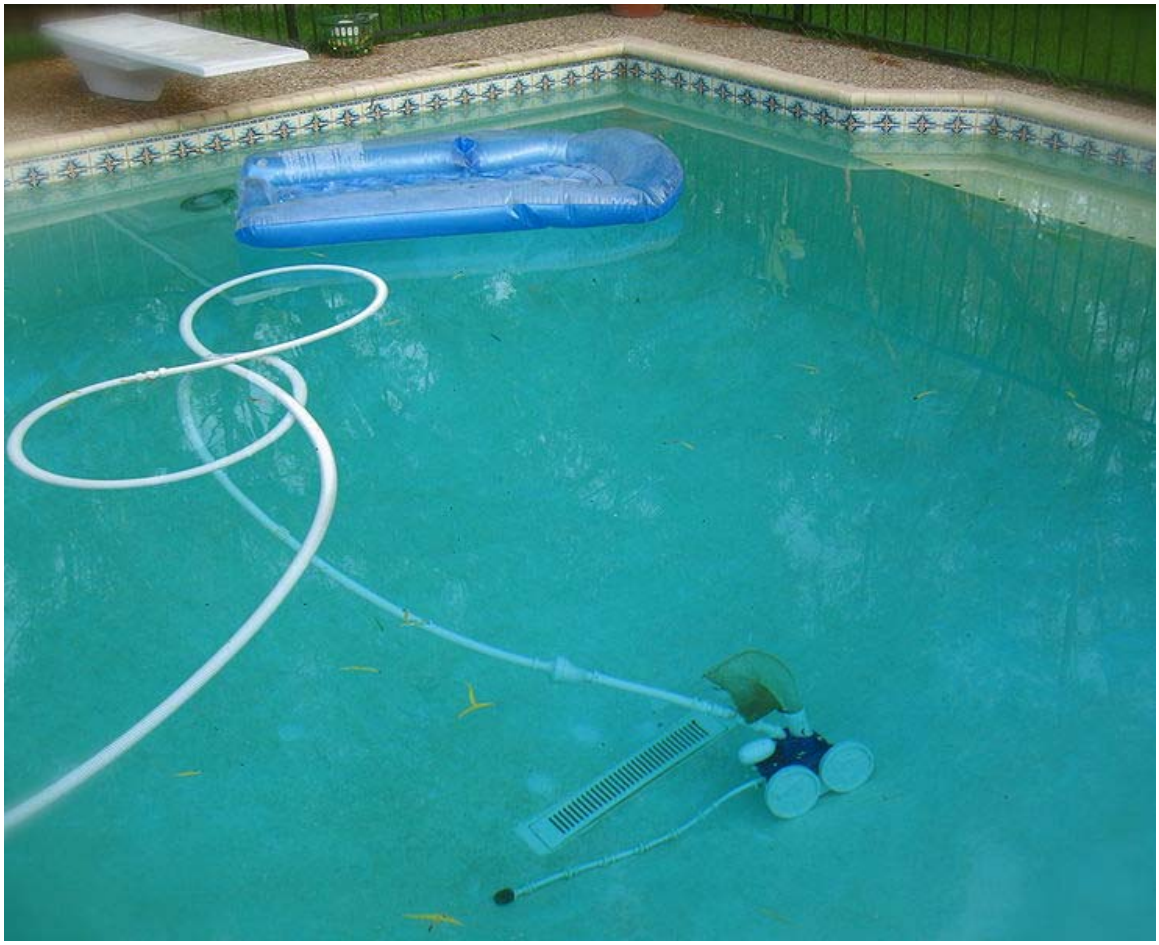
First generation Roomba vacuums the carpets in a domestic environment

A **domestic robot** is a robot used for household chores. Thus far, there are only a few limited models, though science fiction writers and other speculators have suggested that they could become more common in the future. In 2006, Bill Gates wrote an article for *Scientific American* titled "A Robot in Every Home".

Many domestic robots are used for basic household chores, such as the Electrolux Trilobite, Roomba and the SLAM based Neato Robotics vacuum cleaner robot. Others are educational or entertainment robots, such as the HERO line of the 1980s or the AIBO. While most domestic robots are simplistic, some are connected to WiFi home networks or smart environments and are autonomous to a high degree. There were an estimated 3,540,000 service robots in use in 2006, compared with an estimated 950,000 industrial robots.

Specimen of Domestic Robots:-

Automated pool cleaner



Below ground, outdoor pool. Automated pool cleaner visible at bottom.

An **Automated Pool Cleaner** is a vacuum cleaner intended to collect debris and sediment from swimming pools with minimum human intervention. Pools using such a cleaner on a routine basis are not only visually cleaner but also using less chemicals which means lower operating costs.

History

The first swimming pool vacuum cleaner was invented by Ferdinand Chauvier in South Africa, a hydraulics engineer who came to South Africa from the Belgian Congo in 1951.

Chauvier continued to tinker with machines, eventually creating one that would do the job automatically, powered by the operation of the pool's filter. In 1974 he finished work on the first automatic pool cleaner.

Types

Weda B480 automated pool cleaner

There are four main types of cleaners, classified by the drive mechanism used:

- *Return-side driven*—water outflow being returned to the pool is used for locomotion and debris suction, via the venturi effect.
- *Pressure driven*—a minor variation of return-side driven, water outflow is pressurized using a secondary "booster" pump. This high pressure water is used for locomotion and debris suction, via the venturi effect.
- *Suction-side driven*—water being pumped out of the pool via its skimmer or drains is used for locomotion and debris suction.
- *Electronic & Robotic*—an external electrical power cord is used to drive motors used for locomotion and suction.

Return-side driven

These types of cleaner require high amounts of flow for movement, and as a result may require a dedicated pump or adjustment of returns to provided adequate flow to the cleaner.

The venturi effect forces the cleaner forward and allows it to remove of dirt, this dirt and water mixture is directed through a filter bag.

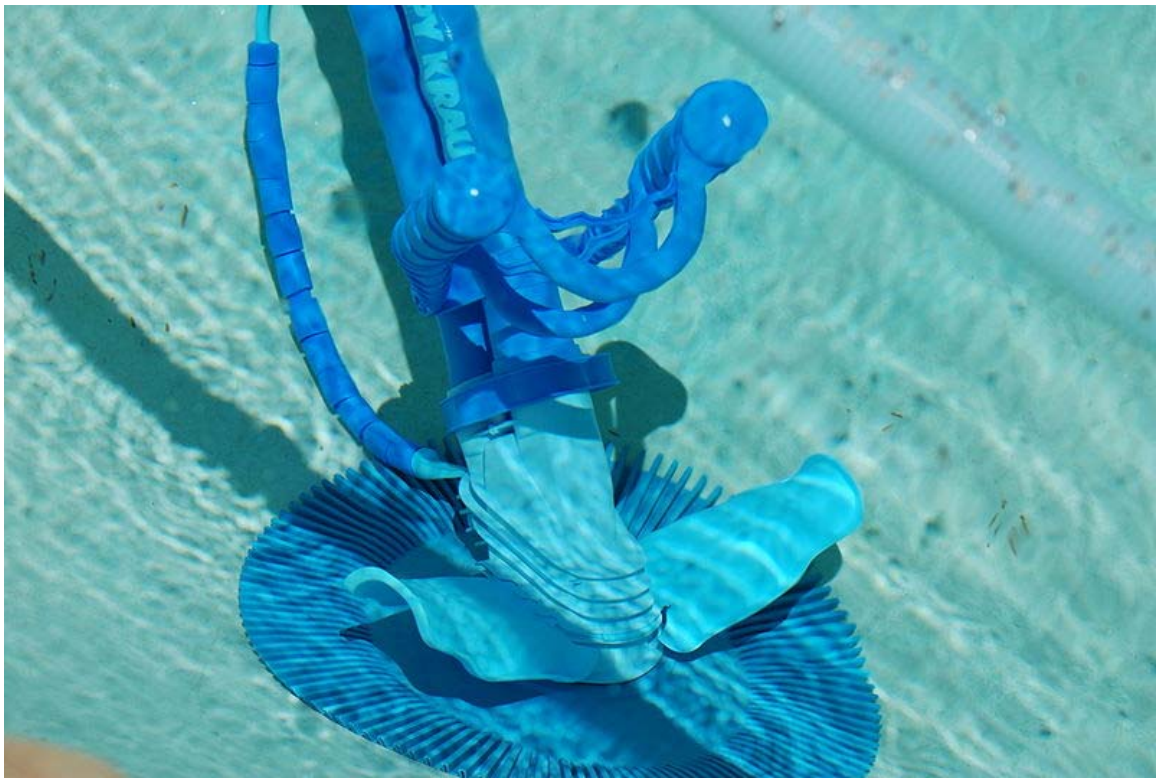
Although a number of older pool cleaners used this process in the past it has fallen out of favour due to high running costs of additional pump & adjustment of return pipework flows.

Pressure driven

This type is identical in principle to the return-side driven, except that a dedicated booster pump is used to provide additional water pressure and flow.

Although a number of older pool cleaners used this process in the past it has fallen out of favour due to high running costs of an additional pump.

Suction-side driven



An example of a Suction-side driven cleaner: A Kreepy Krauly pool sweeper.

This type of cleaner is usually attached via a 1.5 inch hose to a vacuum plate in the skimmer, or to a dedicated vac line on the side of the pool. The suction provided by the pool's pump causes the robot to move forward along the floor and walls of the pool picking up dirt and debris as it moves. The first automatic pool cleaner was a suction cleaner.

Electronic pool cleaners

The central component of the electronic pool cleaner is the motor block, which consists of a drive motor, a pump, and a processor.

As the pump motor draws water in through the bottom of the cleaner, this water travels through filter bags and out the top outlet of the cleaner, which also provides the suction that allows it to clean the sides of the pool. During this cleaning process debris and sand are vacuumed into the filter bags until the programmed cycle is completed. When the cleaner is removed from the pool the filter bags should be emptied and washed by hand before being used again.

The pool robot moves forwards and backwards through the use of wheels or tracks, which are driven by belts connected to the drive motor. Many of these pool cleaners have

a third motor called a foot motor which presses down a rubber foot in order for it to turn and change direction

The processor is configured to an operating time appropriate for the size of the pool.

Robotic pool cleaners

They operate using sensors located in the bump bars, on contact with objects such as a walls they pause the machine briefly. The electronics will then restart the machine and reverse its direction. When this happens it returns in the same direction with a small offset allowing it to move one machine's width over on each crossing of the pool.

Cleaners can be equipped with a timer allowing the machine to start and stop after an adjustable period of time. This delay timer is an important feature for many pools, as many switch off a number of circulation pumps during the night to allow suspended particles to settle on the bottom of the pool; after a couple of hours the pool cleaner begins its cleaning cycle. This cleaning cycle is set up to complete before the pumps are turned back on; this maximizes the cleaning capability of the cleaning cycle. This isn't a necessity as the cleaning capability of the pool cleaner is still considerably high regardless of the circulation pumps.

Unlike hydraulic pool cleaners, these are fitted with thick rotating brushes that thoroughly scrub the tiles clean and trap the dirt in washable filter bags. Suction power is used to grip the floor, ensuring the tiles are scrubbed clean and debris is removed from the pool.

Domo (robot)

Domo is an experimental robot by the Massachusetts Institute of Technology (MIT) designed to interact with humans. The brainchild of Jeff Weber and Aaron Edsinger, its name comes from the Japanese phrase for "thank you very much", *domo arigato*, as well as the Styx song, "Mr. Roboto". The Domo project was originally funded by NASA, and has now been joined by Toyota in funding robot's development.

Purpose

Domo was created as a research platform that would take a closer look at the design concerns of transferring human skills to a machine. The primary research topics for Domo are manipulation of objects, perception of objects and creating a model of understanding how to interact with objects.

Origin

The home of the Domo Project is with the Humanoid Robotics Group (HRG) at MIT Artificial Intelligence (AI) Labs. Its existence is inspired by the robot projects that came before it.

The Cardea Robot Project was a research project led by Professor Rodney Brooks in the Humanoid Robotics Group at MIT. The lab group worked to create a cable-drive brushless Series Elastic Actuator arm mounted to a Segway platform. Jeff Weber and Aaron Edsinger-Gonzales were a part of this research, specifically responsible for the design and implementation of the robotic arm. This collaboration allowed Edsinger-Gonzales and Weber to take some of the research and apply it to a new robot, Domo.

Edsinger and Weber collaborated on many other robots as well, and their experience working with the Kismet page and Cog projects influenced the design of Domo. Kismet was a robotic head developed by Cynthia Breazeal for experimenting with social expressions and cues. Edsinger's role in the project was helping to develop the early stages of Kismet's eye detection module, which allowed Kismet to make eye contact while interacting. The Cog project was intended to explore the way that intelligence is formed through social interaction. The Cog robot was designed to emulate the human body's motor points and limbs and to accept input stimuli from these so that it could use it's limbs in a human-like way. Edsinger's contribution to the Cog project was a Series Elastic Actuator arm and controllers for the body of the robot. Though the research direction of these robots is very different from the Domo Project, the design of the eye detection module and the Series Elastic Actuator arm are integrated into Domo's design.

Design

Domo was created in order to research manipulation and interaction with stimuli and machine learning of sensorimotor skills. To accomplish this the design was required to have particular consideration as to how the robot would be able to interact with unfamiliar stimuli. The research also required Domo to be able to perceive and act upon it's surroundings. Satisfying these concerns meant that Domo needed to be able to function without a complete model of the world, rather, it was equipped with the ability to build a model for itself.

Mechanical Parts

Head

Domo's robotic head consists of 7 degrees of freedom (DOF) for the upper head which is attached to a neck with two DOF. There are two eyes, each with a single wide angle camera. The cameras are capable of video capture at either 640x480 at 30 frames per second (FPS) or 1024x768 at 15 FPS. The two cameras tilt along the same DOF, but have individual DOF for to allow for independent panning. A set of eyelids are included to use for expressions.

Heads of previous robots, such as Cog, were impeded by the bundle of electrical cords that would run to the eye cameras and motors. Domo's design runs all of the cables down through the neck so that they are tucked out of the way. This allows Domo a great deal of range and freedom in head articulation.

The head movement is facilitated by brushed direct current motors. Potentiometer position sensors in the motor provide feedback as to the head's absolute position at startup, so Domo does not require a calibration routine before being able to function.

The main focus of the head design was for Domo to be able to emulate human eye movement. Human eye movements range from very quick and explosive movements to slow and accurate movements for following moving stimuli, so careful consideration was needed to design Domo's head and vision system.

These eyes are linked to a cognitive system that is a networked cluster of Linux machines. The YARP software suite is utilized for the cognitive system to do visual processing.

Arms

Rather than designing Domo's arms for absolute precision, Edsinger and Weber designed the arms to work more closely to that of a human. Human arms are adept at sensing and controlling the forces at every joint, giving up precision in position for compliance. Translating this to a humanoid robot required the design to include some tolerance and compliance at every joint while also being able to keep track of and output torque.

Domo's arms have 6 DOF, two at the shoulder and 4 in the arm and wrist. The joints are Series Elastic Actuators (SEA) driven by custom brushless DC motors. The DOFs contain cable drive systems, with the drive cables hidden discreetly in the center of the joints to not impede movement. Series elastic actuators are used to provide force sensing capabilities to the arms. The sensors embedded through out the arms are linked up to the cognitive system.

Hands

The design of a humanoid hand is required to incorporate some way to measure and output force. A few older designs had force sensors in the fingertips. While this would work in a known environment, it does not provide enough feedback to work in a novel and unknown environment. The controllers in Domo's hands are able to sense forces at the individual joints. This allows the hands to execute a grasp of an object even without a model of the object's size, shape or material.

Each hand consists of three fingers powered by four actuators. There is one actuator for each finger and the fourth is to control the spread between two of the fingers. The two fingers are spread using gears, while the third remains in place.

Abilities

Domo will adapt to its surroundings by testing the physical nature of things by touching them or shaking them. Its abilities include determining the volume of an item, placing items on shelves, pouring drinks for humans, shaking hands, and giving hugs.

Perception

Using the two cameras mounted on its head and the visual processing system, Domo is able to analyze the size and shape of an object to prepare for interaction. This is done without prior knowledge about an object and allows Domo to accomplish tasks in unknown environments.

Learning

Domo's architecture allows for the robot to remember previous sensory experiences. Domo is able to learn about its own sensorimotor abilities and is able to fine-tune the modulation of its actions based on previously accomplished tasks.

Manipulation

Domo's hands were designed to be dexterous and capable of many different grasps and movements. However, this cannot be accomplished without the design of the software system to be adept at managing different controllers for each of its joints. This allows the robot to be able to react quickly and change it's arm activity. This is critical for the robot to be able to attempt to perform real world tasks.

Modulus robot

The "Moddy" setup of the Modulus robot.

The household robot **Modulus**, described by the manufacturer as "the friend of homo sapiens", was made by Sirius, a company Massimo Giuliana set up in 1982 for marketing home and personal computers, and which decided to start building its own domestic robot back in 1984. When the first "Modulus" prototype had been realized, the company asked Isao Hosoe, a Japanese designer who has been living and working in Milan for many years, to study its "body-work". Hosoe's work, however, went well beyond this, and was followed by a complete technological reprocessing of the robot. Data Process was responsible for the design and manufacture of the electronic and mechanical parts, while Sirius used the expertise of an American company, the Robot Sciences Corporation, for the software (its founder, Joseph H. Bosworth, is known by some as "the father of personal robotics").

Development

Two million dollars were invested in developing this particular piece of equipment. Research carried out in the United States showed that there would be greater development in this sector. It was also estimated that the use of "Modulus" could provide an opportunity to bring back into operation many PCs that were bought during the boom, but which are not used seldom, if ever. A good slice of the "Modulus" market could consist of the owners of these personal computers, newly aware of the possibility of connecting them to a personal robot.

"Modulus" was designed as a robot with possible domestic applications, but in reality it is open to any future development. Modularity - hence its name - is one of its principal characteristics, and it has been designed for adaptation to the widest possible range of applications. Comparing the robot with man, "Modulus" can be said to have an electronic "circulatory system" that permits the various extremities (arms, head, etc.) to communicate with the brain (CPU in a computer). The "Modulus" robots could have abilities such as a phonemes synthesizer, voice recognition, infra-red communication, etc., making it suitable for performing many functions ranging from helping to teach children to assisting the handicapped or invalids.

When studying the eventual appearance of "Modulus", Isao Hosoe began by looking at the robots of the past. These included "Electro", built by Westinghouse in 1939. Hosoe hit on the right appearance by studying human expressions and gestures, bearing in mind that a domestic robot needs to be appealing on account of its proximity to man. Its eyelids have to open, its pupils dilate or contract. It must be able to nod or shake its head, bend its torso, and raise, lower and rotate its arms. "Modulus", however, has no feet. Available in three configurations - "Base", "Service & Security" and "Moddy" - "Modulus" stands on a Base unit 35 cm in diameter and 15 cm high, two two-speed motors connected to rubber wheels, and two spherical stabilizers. It comes with a small infra-red Instrument for connecting it to another remote control device or for interacting with the major home and personal computers.

Base

This first unit can be added to for different functions. As it stands it can be used in hobbies as a home computer, self-propelled peripheral, and can be useful for people wanting to learn to program robots. The simplest attachments which can be connected to the Base unit are a vacuum cleaner and a plotter-mechanism that uses felt pens, etc., to produce drawings of considerable precision.

Service & Security

The second "Modulus" configuration, the Service Robot, is obtained by fitting the Techno-cake home-security and service unit on to the Base. One of the components allow the robot to signal the presence of smoke, gas, water, and intruders; at the first sign of

danger it informs the computer or triggers a siren or preset vocal message. An arm with ample freedom of movement and considerable gripping power can be added to the Service Robot. Using its meteo-system, the robot will fetch its owners umbrella if it is going to rain; a simple whistle will bring it toddling over to you.

Moddy

Moddy is the third and most advanced version of the robot. It is obtained by adding a torso, two arms, and a head to the other two units. The robot can carry a tray with its two arms. Its head and big eyes making it into a really human character, reliable, and a companion to play with. It is not surprising then if Isao Hosoe, who designed "Modulus" together with Ann Marinelli, Donato Greco, and Alessio Pozzoli, also received special advice from his two children, ten-year-old Takeo and fifteen-year-old Taro.

The first two units were previously available on the market. Base complete with vacuum cleaner and plotter-mechanism, cost about a million lire, while the price of the Techno-cake varied from two to five million lire, depending on the type and number of components in function (not all the components were available yet, on account of the time needed to develop the software). It would probably take up to a year before Moddy was ready which would cost between eight and ten million lire, but unfortunately Sirius became bankrupt before the "Modulus" project could be completed, and some of the robots had to be sold to companies that distributed them for the aid of handicapped while the rest of the Moddy robots were sold to a Norwegian company called Arngren Electronics A/S where they were re-sold during the early 1990s.

picaBot

picaBot floor vacuuming robot.

picaBot is a domestic robotic floor cleaner that sweeps, vacuums, and disinfects floors simultaneously.

Description

Photocatalytic UV tube on the underside to kill harmful microbes.

picabot originated from the words *pica* and *robot*. Pica means a craving to eat substances that has no nutrition like dirt or chalk. Literally translated, **picabot** is a robot that likes to eat rubbish.

picabot eVo2, based on QQ2L by Metapo Inc, was launched in July 2008. It operated on rechargeable Nickel-Metal Hydride (NiMH) battery, comes with a docking station(home base), power adaptor, remote control and a spare filter. The robot would return for recharge automatically whenever it finished its job, the battery level is low or anytime commanded to return with a remote control.

Since Metapo first launched the US version of the robot called Cleanmate QQ1 in the US market sometime in 2003, it has undergone several upgrades including 3 major ones. Compare to QQ1, the QQ2L has improved much on its Artificial Intelligence(AI), battery run time and product reliability.

picaBot eVo2 has further improved on the floor disinfecting, the suspension system and battery pack of the robot compare to the US version of QQ2L. The result is better germicidal effect when it added photocatalysis to the UV tube mounted on the bottom of the robot. The improved suspension system allow the robot to traverse different type and

height of floors with greater ease. Higher spec battery increase the robot's running time significantly.

How it works

Brush on the underside for sweeping up debris.

Domestic robotic floor cleaners are made to be as easy to use and maintain as possible. Like most other popular brands like Electrolux, Karcher and iRobot, it is rather intuitive to use and maintain **picaBot eVo2**. Just press the "Start" button and you can leave the room or house with it. **picaBot eVo2** sweep, vacuum and disinfect the floor simultaneously. While the sweeping and vacuuming will be activated by default once the robot starts running, the photocatalytic UV floor disinfecting function needs activation with the remote control. It moves around in random alternate between several pre-programmed moving patterns; straight-and-bounce(zig-zag), spiral, along-the-wall, ladder-shaped and polygonal in order to fully cover a given room. Generally, picaBot takes about 10 minutes to cover a 100sq ft area.

Unlike iRobot's Roomba, **picaBot eVo2** sweep and vacuum simultaneously while the Roomba sweep and vacuum in separate compartments/inlets. picaBot uses a side brush to sweep in dust and debris from the side (and edges of the wall) and a main brush 'kick'

them towards the vacuum inlet so that the vacuum can easily suck them into the dust box. This "combined" sweeping and vacuuming design makes picaBot stronger and more thorough in cleaning smaller particles like dust, lint, hairs and fur. It is therefore understandable that oriental market seems to favor this "combined" cleaning action as most families practice bare foot culture indoors. Even a very small amount of dust would cause discomfort and concerns. Furthermore, it also has a small UV tube coated with photocatalytic Titanium Dioxide on the underside of the robot that helps to eliminate organic micro-organism like germs and dust mites on the floor. Users need to take note that loose items like string, cable and clothes that can possibly get caught by the spinning brushes are to be cleared off the floor where the robot is supposed to cover. By the end of its cleaning cycle, the robot will go back to the home base to recharge automatically. When it is time to recharge, it will make 2 circles before moving straight to any solid object(most probably a wall) and start to move along the wall in clockwise direction to locate the charger(or called "home base"). The advantage of this method of docking station(charger) seeking is that the successful docking rate is higher but it usually take longer time to reach the docking station.

The filter and dust box are washable to minimize flying dust when clearing the dust box. Three anti-fall infra-red sensors mounted under the body detect steps or edges about 4 cm or deeper to prevent it from falling down such steps. With a dimension of 34 cm diameter and 9 cm height, it is reasonably nimble to move around and under furniture. Nevertheless, due to the top of the front bumper is designed to be in line with the body of the robot,it is possible that it may get wedge in with overhead object which has a very small declining angle. In most cases, it will struggle and free itself but there may be cases it get stuck and need human intervention. picaBot eVo2 also come with a slim remote control at 1 cm thick which can be place fittingly onto the top cover of the robot. Functions on the remote control include: driving the robot(left, right, forward, reverse), cleaning duration setting, start, stop and shut down the robot, moving pattern selection, home returning, switch on and off the germicidal photocatalytic UV tube and switch on and off the vacuuming function.

Maintenance is relatively easy. There is only 1 dust box to clear of rubbish. Users are advised to wash the filter every time, clearing the rubbish to reduce flying dust and at the same time to prolong the useful life of the filter.

In case picaBot moves through a puddle of water, it will not cause any harm as the turbine inlet is designed to be located at a higher position to avoid water or any liquid entering the machine through the inlet. Simply dry up the dust box and filter would suffice.

More improvement needed

While it does not affect hard surface tiled, marble, matt lacquered and laminated wooden floor, the fixed axle front wheel can possible cause light turning marks on glossy lacquered floor when the robot change direction. The moving speed of the robot is a tad slower at 1.8m/s than iRobot(3m/s) making one to wonder if it is necessary to move at

that low speed to clean effectively. Some users have reported that their robot's battery capacity are below what the manufacturer claimed of 70 to 100 minutes run time. They have to get the battery replaced to achieved the claimed run time. However, this issue has been resolved since early 2009 with its new battery supplier. The vacuum inlet is too narrow (approximately 1 cm) to take in anything bigger than something the size of a rice making picaBot eVo2 effective in picking up small particles, dust and hair but not pebbles or crumpled pieces of paper.

Latest development

In early 2009, the issue of short run time has been resolved with the new battery supplier. The latest picaBot eVo2M which was launched in early February 2010 with a 2800mAH battery pack has received favorable feedback from users with many claiming run time of more than 100 minutes. Besides upgrading done in Malaysia, Corvan also introduced a 100% run-in program since 2008 where every robot is run a full cycle with all functions working. The objective of the upgrade and 100% run-in program is to improve the reliability of the robot.

Roomba

Roomba in action

Third Generation Roomba docked in base station

The **Roomba** is an autonomous robotic vacuum cleaner sold by iRobot. Under normal operating conditions, it is able to navigate a living space and its obstacles while vacuuming the floor. The Roomba was introduced in 2002; as of January 2008, over 2.5 million units have been sold. Several updates and new models have since been released that allow the Roomba to better negotiate obstacles and optimize cleaning.

Description

Roomba Discovery

The unit is a disc, 34 cm (13.4") in diameter and less than 9 cm (3.5") high. A large contact-sensing bumper is mounted on the front half of the unit, with an infrared sensor at

its top front center. A carrying handle is fitted on the top of the unit. Depending on the model, it may come with between one and three "Virtual Wall" infrared transmitter units.

There have been three generations of Roomba units: The original Roomba, Pro, and Pro Elite; the second-generation "Discovery" series with a larger dustbin, dirt detection, and optional home base; and the newest 5XX series.

The Roomba operates with internal nickel-metal hydride batteries (NiMH) and must be recharged regularly from a wall plug, although newer second and third-generation models have a self-charging homebase they automatically try to find (via its infrared beacon). Charging on the homebase takes about three hours. All second and most third-generation Roombas can be used with the homebase, even if they do not come packaged with it. First and second-generation models came packaged with a twelve-hour charger, although a three-hour rapid charger could also be used with them.

First-generation models needed to be told the size of the room via three room size buttons (Small, Medium, and Large), but this is no longer required with second and third-generation models.

Operation

This EU Roomba is similar to the second-generation US Roomba Sage.

Using a second- or third-generation Roomba consists of carrying it to wherever the owner would like it to start, pressing the "power" button, then pressing the "clean", "spot", or "max" (if applicable) button. Third-generation Roombas no longer have the "max" button, but include a "dock" button allowing the owner to instruct the Roomba to dock with its homebase. A second- or third-generation Roomba may also be used with the Scheduler accessory. It allows the Roomba to begin cleaning automatically at the time of day that the owner desires. This can be useful for people who want the Roomba to clean while they are at work.

The Scheduler accessory is not compatible between second and third-generation Roomba.

When the "clean", "spot", or "max" button is pressed, the Roomba begins its work. The contact bumper detects bumping into walls and furniture, and the Virtual Walls limit the Roomba to the areas that the owner desires with an infrared signal. Special Scheduler Virtual Walls can be programmed to turn on at the same time the Scheduler-enabled Roomba is activated. Four infrared sensors on the bottom of the unit prevent it from falling off ledges. Second- and third-generation models have additional dirt sensors that allow them to detect particularly dirty spots and focus on those areas accordingly.

Unlike the Electrolux Trilobite vacuuming robots, Roombas do not map out the rooms they are cleaning. Instead, they rely on a few simple algorithms such as spiral cleaning (spiraling), room crossing, wall-following and random walk angle-changing after bumping into an object or wall. This design is based on MIT researcher and iRobot CTO Rodney Brooks' philosophy that robots should be like insects, equipped with simple control mechanisms tuned to their environments. The result is that although Roombas are effective at cleaning rooms, they take several times as long to do the job as a person would. The Roomba will cover some areas many times, and other areas only once or twice.

After a period of time in "clean mode", the Roomba stops and sings a few triumphant notes. The duration in "clean mode" depends on room size and volume of dirt. Third-generation models estimate room size by measuring the longest straight-line run they can perform without bumping into an object. First-generation models must be told the room size. After cleaning, if a home base is detected a second or third-generation Roomba will try to return to it. While in contact with the home base, a Roomba will charge its battery. The owner then removes the dustbin from the unit's rear and empties debris into a trash can. With the exception of the first-generation Roomba, an infrared remote control can also be used to control the unit, which is useful for a disabled person.

The Roomba is not designed for deep-pile carpet. The first and second-generation Roombas would get stuck on rug tassels (though they could be tucked under for running a Roomba) and electrical cords. The third generation has a release mechanism in the brush deck and will not only pass over tassels and electrical cords, it will actually clean them. It is low enough to go under a bed or other furniture. If at any time the unit senses that it

has become stuck, no longer senses the floor beneath it, or it decides that it has worked its way into a narrow area from which it is unable to escape, it stops and sounds a mournful tone to help its owner find it.

The third-generation Roomba, which moves faster than previous Roombas, has an infrared bumper so it can go slower when the device senses it is about to run into an object.

Models

First generation Roomba

The first-generation Roombas have three buttons for room size.

The second-generation Roombas (dubbed "Discovery") replaced their predecessors in July 2004, adding a larger dust bin, better software that calculates room sizes, fast

charging in the home base (or wall hanger in the Discovery SE), and dirt detection. All second-generation Roombas are functionally identical, though some have more or fewer buttons, accessories, or casings, and all featured updated programming after mid 2005. The low-end models continue to be available as of 2007 with new model names. All 2G Roombas can be updated to 2.1G Roombas.

The third-generation 5xx Roomba was introduced in 2007 and features an infrared sensor to detect obstacles, a dock button, and improved mechanical components. Some second-generation models remain on sale, however, as the 4xx series.

Roomba Budget models (Dirt Dog and Model 401) have a simplified interface (a single "Clean" button) and lack some of the program generated flexibility of other versions. They are positioned to be less expensive versions of the Roomba for first-time purchasers. The Roomba Dirt Dog contains sweeping brushes and a larger dust bin but lacks the vacuum motor. It uses the space required for the vacuum for additional dust bin volume. It is designed for home shop or home garage environments. The Roomba Model 401 is similar but has a 'standard' size dust bin and vacuum system. They are compatible with the extended-life batteries, fast charger and schedulers of the Discovery series.

Accessories

- Easy Clean Brush: A brush that is designed specifically for cleaning pet hair, and being easier to clean off (standard on "for pets" models).
- Remote Control: Allows the owner to control the Roomba remotely (works with all second and third generation Roombas).
- iRobot Scheduler: Allows the owner to program the Roomba to clean at certain times automatically. Schedule Upgrade accessory will also update a pre-2.1 Roomba to the 2.1 software (for third generation Roombas).
- Homebase: The Roomba automatically returns to here for recharging (for second and third generation Roombas).
- Virtual Wall: Used for keeping the Roomba out of certain areas (for all Roombas).
- Virtual Wall Lighthouse: Functionality of Virtual Wall in addition to 'Lighthouse' mode which will contain Roomba in one room until the room is completely vacuumed before moving on to the next.
- OSMO: A dongle that attaches to the serial port on the Roomba. This updates a pre-2.1 Roomba's firmware to version 2.1 and can also correct the "circle dance" problem (for all second generation Roombas).
- Advanced Power System (APS) Battery: Rechargeable battery for all Roomba models that holds enough power to clean for 200 minutes.
- Roomba Serial Control Interface (Roomba SCI) exposes all the functionalities and sensor information from the iRobot Roomba vacuum cleaner. Using the Roomba SCI a roboticist can command and control the Roomba by interfacing to the 7pin Mini Din UART port.
- Roo series of products: RooTooth, RooStick and Roo232 by RoboDynamics

    - RooTooth: A Bluetooth module that converts the RoomBa to Bluetooth control from any bluetooth device.
    - RooStick: A Bluetooth dongle to allow control from BlueTooth enabled devices
    - Roo232: Allows programming input through a serial port connector.
- RoombaFX - A C# class by RoboDynamics that implements the entire Roomba SCI command set.

Hacking and extending Roomba

Roomba comes with a Mini-DIN TTL serial interface, which is incompatible with standard PC/Mac serial ports and cables, both electrically and physically. However, third-party adapters are available to access the Roomba's computer via Bluetooth, USB, or RS-232 (PC/Mac serial). New, 500-series, and 410/420 series Roombas upgraded with the OSMO hacker device allow the user to monitor Roomba's many sensors and modify its behavior. The Roomba Open Interface (formerly "Roomba Serial Command Interface") API allows programmers and roboticists to create their own enhancements to Roomba. Several projects are described on Roomba hacking sites. In response to this interest, the company manufactures the iRobot Create, with the vacuum cleaner motor replaced by a "cargo bay" for mounting devices like TV cams, lasers, and even non-mobile robots. The Create provides a greatly enhanced, 25-pin interface providing both analog and digital bidirectional communication with the hosted device. Thus, it can then be used as the mobile base and wireless interface for completely new robots.

Chapter- 2

Various Domestic Robots

Scooba

Scooba is an automated robotic floor washer produced by iRobot. It was released in limited numbers in December 2005 for the Christmas season at $399.99 USD, with full production starting in early 2006. The company introduced a $299 version, the Scooba 5800, in the second half of 2006.

The Scooba uses a special non-bleach cleaning solution made by The Clorox Company that cleans the floors and prevents rust or skidding and has been nicknamed *Scooba juice*. The robot preps the floor by vacuuming loose debris, squirts clean solution, scrubs the floor, and then sucks up the dirty solution leaving a nearly dry floor behind. The robot is safe to use on sealed hardwood floors and most other hard household surfaces, but it cannot be used on rugs. Scooba avoids rugs and stairs, and can clean about 200 square feet (19 m^2) on a single tank-load of solution.

The Scooba is the second major commercial product made by iRobot, which popularized vacuum robots with the Roomba. The Scooba is available in over 40 countries.

Details

The Scooba uses approximately 2 fl.oz. (63 ml) per cycle, mixed with a quart (1.1 L) of water to fill the clean solution tank. The Scooba comes with one 8 oz (240 ml) bottle of the Clorox Scooba Cleaning Solution, which is enough for about four washings. Additional Clorox Scooba Cleaning Solution comes in five-packs and nine-packs of 32 oz (960 ml) bottles, which provide enough solution for about 16 washings per bottle. Polysorbate 20 and tetrapotassium EDTA are the primary ingredients. It can also use white vinegar in place of the proprietary solution.

Recharge times may vary, but typically takes 3 hours.

Models

Generation 1

Scooba 5900 was the first Scooba, it could only be used with the Scooba Cleaning Solution and was discontinued in favor of the slightly improved Scooba 5800 (basic floor washing model).

The Scooba 5800 can clean about 250 square feet (23 m^2) per battery charge ($299)

Generation 2

Scooba 330 can clean 250 square feet (23 m^2) per battery charge ($299)
Scooba 350 (intermediate floor washing model) can clean about 500 square feet (46 m^2) per battery charge ($399)
Scooba 380 (premium floor washing model) can clean 850 square feet (79 m^2) per battery charge. Also includes charging base, storage mat, and an extra virtual wall (for a total of two) ($499)

Toyota Partner Robot

The **Toyota Partner Robots** are a series of humanoid robots developed by Toyota. They debuted playing music on drums and trumpets at the 2005 World EXPO in Aichi, Japan. There are 5 robots in all, most of which have different movement systems. The 5 robots are: **Version 1** (bipedal robot), **Version 2** (Segway-like wheels), **Version 3** (Segway-like wheels), **Version 4** (unique wire system) and the **i-Foot** (mountable with 2 legs). In July 2009, Toyota released a video of the running and standing skills of their partner robot. The robot reaches 7 km/hour, however walking and running can only be achieved on flat surfaces.

The walking type playing the trumpet.

The wire type.

The i-Foot.

Ulysses (robot)

Ulysses is a bomb-detecting robot at the Greek Eleftherios Venizelos International Airport named after the Greek mythological character Odysseus.

Wakamaru

Wakamaru greeting people

Wakamaru is a Japanese domestic robot made by Mitsubishi Heavy Industries, primarily intended to provide companionship to elderly and disabled people. The robot is yellow, 1m tall, and weighs 30 kilograms. It has two arms and its flat, circular base has a diameter of 45 cm. The first hundred went on sale in September, 2005, for USD $14,000.

Wakamaru runs a Linux operating system on multiple microprocessors. It can connect to the Internet, and has limited speech (in both male and female voices) and speech recognition abilities. Functions include reminding the user to take medicine on time, and calling for help if it suspects something is wrong.

Wakamaru was the childhood name of Minamoto no Yoshitsune. It was named after him.

Robotic lawn mower

A **robotic lawn mower** is an autonomous robot used to cut lawn grass. A typical robotic lawn mower requires the user to set up a border wire around the lawn that defines the area to be mowed. The robot uses this wire to locate the boundary of the area to be

trimmed and in some cases to locate a recharging dock. Robotic mowers are capable of maintaining up to 5 acres (20,000 m^2) of grass.

Robotic lawn mowers are increasingly sophisticated, are self-docking and some contain rain sensors if necessary, nearly eliminating human interaction. Robotic lawn mowers represented the second largest category of domestic robots used by the end of 2005.

Brands

Husqvarna Automower

Husqvarna

The Husqvarna AB Automower was the first robotic mower made available through mainstream channels. Between 1995 and 1999 Husqvarna introduced their first fully solar robotic mower and their first Generation 1 automatic robotic mower. From 1995 through 2003 Husqvarna's Automower was successful. However, Husqvarna's boom in robotic mower sales really began in 2004 with the introduction of the Generation 2 Automower.

Originally branded the Electrolux Automower after Husqvarna's parent company at the time, the Generation 2 machine featured many advancements not previously seen. The primary advancements were the ability for the mower to find its charging station via radio frequency, by following the boundary wire, or by following an optional guide wire. This

improvement eliminated wear patterns in the lawn caused by the mower only being able to follow one wire back to the station.

The Generation 2 Automower also had the ability to be easily programmed to follow the guide wire or the boundary wire out of the station to remote areas so the mower would always get to all areas of the lawn even if accessible only through narrow passages. Improved wheel motors and more aggressive wheels provide more stability on hillsides. the blade height adjustment was made accessible from the top of the machine versus from below on the Generation 1.

Models

210C

The 210C is designed for smaller lawns. The mower is designed to be put out by the owner one or two times a week and the mower mows up to five hours at a time. The mower is then stored until the next mowing.

220

This model is powered off a standard 110 volt power supply. This mower is fully automatic, and will find its way back to the station on its own, and is fully programmable. The 220AC is designed for lawns up to 0.5 acres (0.20 ha).

230ACX

The 230ACX is similar to the 220AC but with twice the battery strength and more powerful wheel motors. The 230ACX to handle lawns up to 0.75 acres (0.30 ha). The 230ACX also comes with the ability to run two guide wires, and program up to five remote areas.

Automower Solar Hybrid

The solar hybrid is designed to draw as much of its power supply as possible from the sun. The solar hybrid's functionality is very similar to the 230ACX with exception to the solar technology.

260ACX

The 260ACX handles up to 1.5 acres (0.61 ha) of lawn, and has built in anti collision sensors and is able to send mobile text messages.

Robomower

The Robomower is a robotic mulching lawnmower made by Friendly Robotics. Invented in Israel, the product charges from household current, so it does not directly emit any

greenhouse gases. It was identified by the Guinness Book of World Records as the best-selling robotic lawn mower in the world. It comes with a rechargeable lead-acid battery pack. It can be programmed to mow around the perimeter of the lawn and inside the lawn. It has sensors on the front and on the back. The mower uses tiling algorithms to calculate the most effective pattern for cutting the entire lawn.

LawnBott

The LawnBott is a mower marketed in the U.S. and Canada by Kyodo America Home Robotics. The mowers are manufactured by the Italian engineering company Zucchetti Centro Sistemi, and are distributed in some European countries under the brand names Mowbot, Ambrogio, Oscar, and Wiper.

The mower is programmed to emerge from a recharging station on command or at a scheduled time. The mower will criss-cross a lawn (from edge to edge) at random angles and will spiral randomly usually in the middle of the lawn. The more advanced models can control blade speed based on grass height and spiral when longer grass is found. When the battery is exhausted or the schedule has ended the mower will return automatically to its base to recharge by following the perimeter guide wire.

Models

LB2100 / LB2150 (Professional)

This model uses two lead acid batteries and can cover 0.5 acres (0.20 ha) with slopes of up to 12 degrees. Added in 2009, the LB2150 is the same model but with a single lithium battery and can cover slopes up to 27 degrees.

LB3200/LB3210/LB3250 (Evolution)

This model is the same size as the LawnBott Professional but with a lithium-ion battery. It can cover 0.75 acres (0.30 ha) and 27 degree slopes. Optional spiked wheels allow use on slopes up to 30 degrees. A 2nd internal lithium-ion battery can be added to increase coverage to approximately 1.25 acres (0.51 ha).

LB3500 / LB3550

This model has a single lithium-ion battery with room for two more. It can cover 1 acre (0.40 ha) or up to 2 acres (0.81 ha) with two more batteries..

LB1200 / Spyder

This mode is the first household robotic lawn mower that requires no perimeter wire. It comes with 1 lithium battery. The coverage is 5,500 sq ft (510 m^2) with slopes of up to 27 degrees.

Daizy Mower

Daizy Mower Robotics is a perimeter wire type robotic mower designed to be comprable in quality to other mowers but being more affordable. Daizy Mower is manufactured by Tianchen Robotics and is privately owned by Mark Timms. "Daizy Mower"

Roborior

Roborior is a robot manufactured by the robotics company Tmsuk and marketed by Sanyo. It is used both for lighting and guarding homes. Roborior is roughly the size of a watermelon and can produce different hues of color ranging from blue, purple, and orange. The Roborior is also equipped with a digital video camera that can stream live video directly to the owner's cell phone if it detects an intruder. The Roborior can be controlled remotely with a hand set, much like a Remote control vehicle, as well. It was introduced in Japan in late 2005 and was priced at 280,000 Japanese yen. The name is a portmanteau of robot and interior.

RoboMop

Robomop

The RoboMop®, is a robotic floor duster introduced RoboMop International AS.

The device consists of a hat-shaped frame with an electrostatic dust pad on the bottom, driven by a self-propelled ball, about 8 cm diameter tall, that fits into the middle of the frame. The product is powered by a rechargeable battery that can be plugged into house current.

The product is patented worldwide. Robomop is invented by Norwegian Torbjørn Aasen.

At present RoboMop is currently available in Europe and some Asian countries but will shortly also be available for the US market

Robomaxx

Robomaxx is a robotic vacuum cleaner. However, in stark contrast to most other robotic vacuum cleaners, no vacuum cleaner mechanism is present, nor are there any circuits to decide on which path the robot takes. Instead a kind of swiffer cloth is attached to the bottom of the robot and this pushes the dirt along. The robot changes direction because the central wheel has a differential and thus drives into the direction with the least resistance.

PatrolBot

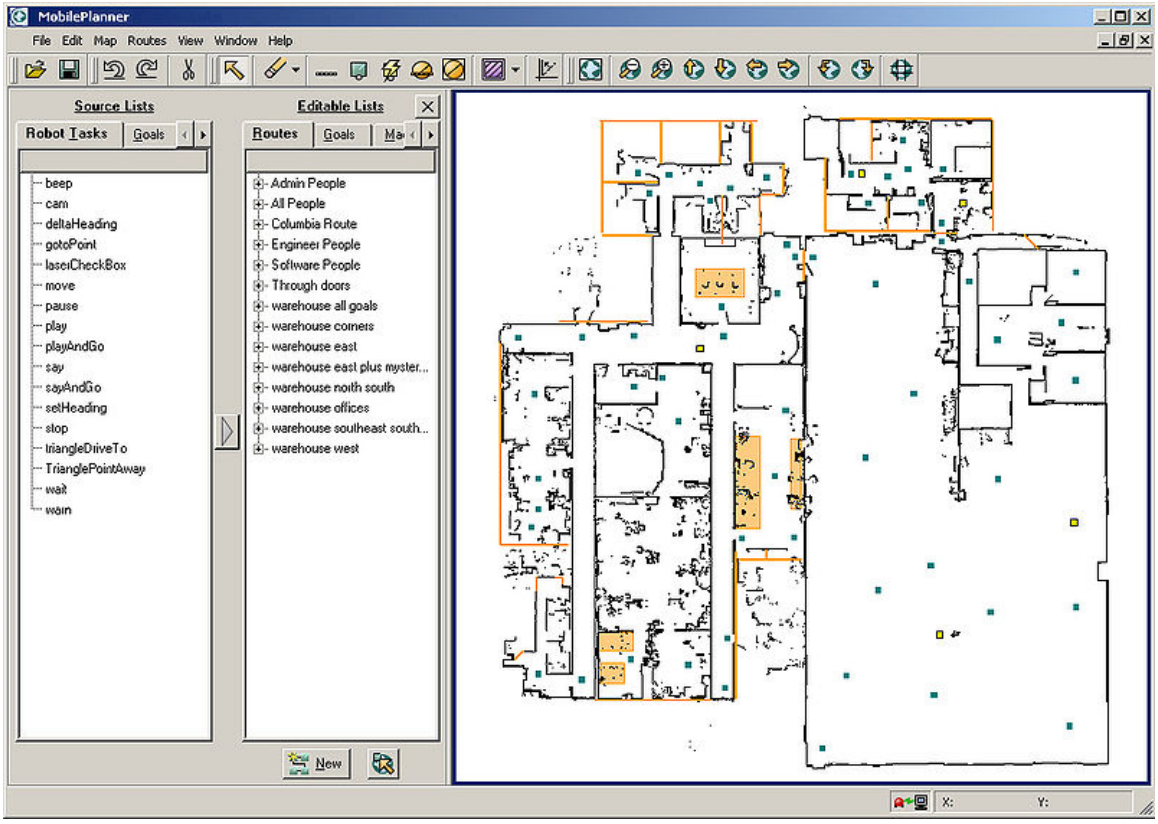
PatrolBot

PatrolBot is a programmable autonomous general purpose service robot rover built by MobileRobots Inc. PatrolBots are manufactured in various configurations and serve as bases for companies developing delivery robots, security robots, environmental monitoring rovers, robot guides and other indoor service robots.

Capabilities of PatrolBot

PatrolBot can scan buildings, create floor plans and navigate them autonomously using a laser range-finding sensor inside the robot. It employs Monte Carlo/Markov-style localization techniques using a modified value-iterated search technique for navigation. It searches for alternative paths if a hall is blocked, circumnavigates obstacles and re-charges itself at its automated docking/charging station as needed. Using a Wi-Fi system the device can operate autonomously or be controlled remotely.

Applications



Robot software "drag-and-drop" interface for setting up goals, tasks and routes for autonomous robots.

PatrolBot is a robotic base used for delivery, security, sensor monitoring, inspection and guidance tasks. It is a reference platform added onto with various carrying attachments, sensors, touchscreens and cameras. While it began primarily as a security robot the platform is now used as a base for a broad range of applications.

Robot Control

Users set up the robot using a GUI interface to give goals, docking location and constraints such as forbidden areas into the robot's map. Then, using drag and drop, an operator can give goal names, tasks and macros into a "route" or program for the robot to follow. Users can then use set or random sequences for the robot to follow by dragging routes into a weekly schedule. Advanced users can communicate with the robot from external systems or program more advance actions over a command language interface as well as add new sensors.

PatrolBot can be sent to goals on demand or can patrol a sequence of goals. Status windows in the control GUI provide read-outs from the sensors as well as proprioceptive information such as battery levels. The robot's data logs are available for security and energy optimization as well as troubleshooting.

My Spoon (feeding robot)

My Spoon is a meal assistance (or feeding) robot produced by Japanese company, SECOM Co. Ltd. It is designed to help disabled people eat using a robotic swiveling arm which has a spoon attachment. It is controlled using a small joystick, and functions with most types of foods.

The spoon stops at a preprogrammed position in front of the mouth so a user can eat from the spoon at his convenience.

The device has won an award in the service category at Robot Award 2006 and sells for approximately 400 000 yen ($US 3 400).

Lewis (robot)

Lewis (named after Meriwether Lewis) is an autonomous robot that performs the job of a wedding photographer: it attends social events, moves around, and takes digital photographs of people. It is a research project of the Media and Machines Laboratory at Washington University.

Lewis has been featured on slashdot, on CNN's website, and in various North American newspapers.

In 2002, Lewis received -- and declined -- an invitation to Nelly's 24th birthday party.

Koolvac

Koolvac is a robotic vacuum cleaner designed by former iRobot Roomba distributor Koolatron. iRobot has filed a lawsuit against Koolatron, claiming that Koolvac is an unauthorized copy of Roomba. iRobot won the court case and all Koolvac's were to be liquidated or exported by October 2005. Koolatron is prohibited from selling Koolvacs within the United States.

Inkha

Inkha is an interactive robotic head which was created in 2002 at King's College London.

Inkha uses a camera in its eye to track the movement of people who come close to it. It moves in a lifelike way based on studies of human movement. Inkha exhibits fright when it sees sudden movements and interest when it sees small movements. It becomes bored and goes to sleep if there is nothing of interest to "see".

Inkha also speaks periodically about facts and astrology and gives out fashion tips.

During 2003 Inkha was enhanced to become a Roboreceptionist at the Strand entrance of King's . This saw the addition of additional sensors, industrial-grade servo motors and a touch screen so that Inkha can give room directions to visitors. So far the Roboreceptionist has been running for over five years, giving out over 52,000 room directions and making over 57,000 comments in this time.

A portable version of Inkha is also available and was installed as a Roboreceptionist at the Cheltenham Science Festival each year between 2004 and 2006. Inkha has appeared on the children's television progamme *Blue Peter* and been the subject of articles in the science journal *Nature* (reprinted here) and *The Times* .

iRobot Dirt Dog

The **iRobot Dirt Dog** is a cleaning robot based on the Roomba platform which replaces the Roomba's vacuum cleaner with a series of brushes designed for cleaning up loose hardware and debris from workshop and garage floors. It is similar to a low-end Roomba, with a simplified user interface, and is compatible with accessories designed for iRobot's other domestic robots. The Dirt Dog lacks a vacuum motor, relying only on brushes for cleaning.

Electrolux Trilobite

A silver Trilobite Version 2.0

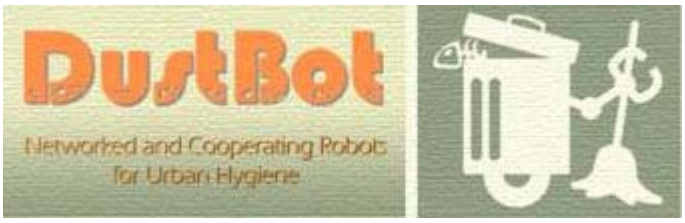
The **Electrolux Trilobite** is a domestic robot vacuum cleaner manufactured by the Swedish corporation Electrolux. It takes its name from the extinct arthropod, which scoured the ocean's floor. The original prototype cleaner was first seen on the BBC television programme, "Tomorrow's World", in 1996; when it was demonstrated by presenter Philippa Forrester. It was the world's first commercially available autonomous vacuum cleaner, introduced as a product in 2001.

The Trilobite contains a vacuum cleaner and a removable roller brush capable of working on deep-pile carpet. It has the ability to map rooms and avoid obstacles by using ultrasonic sensors (on the Mark 2 model also infrared). It recharges itself on a charging base, which it automatically finds when has completed its cleaning task or its power runs low. The Trilobite will indicate when the dustbin needs to be emptied.

Its ultrasonic sensors allow it to come within 1" of objects without colliding with them. This object detection is fairly reliable, but sometimes fails if the robot approaches an object with a sharp corner. In this case, the ultrasonic beam is not reflected, and the Trilobite will gently bump into the object. Because the Trilobite stops a short distance from walls and other objects, it leaves small areas that are not fully cleaned. Magnetic strips are used to block off areas that the Trilobite should not enter, and infrared sensors (on the Mark 2 model) protect it from falling down stairs or off ledges.

Dustbot

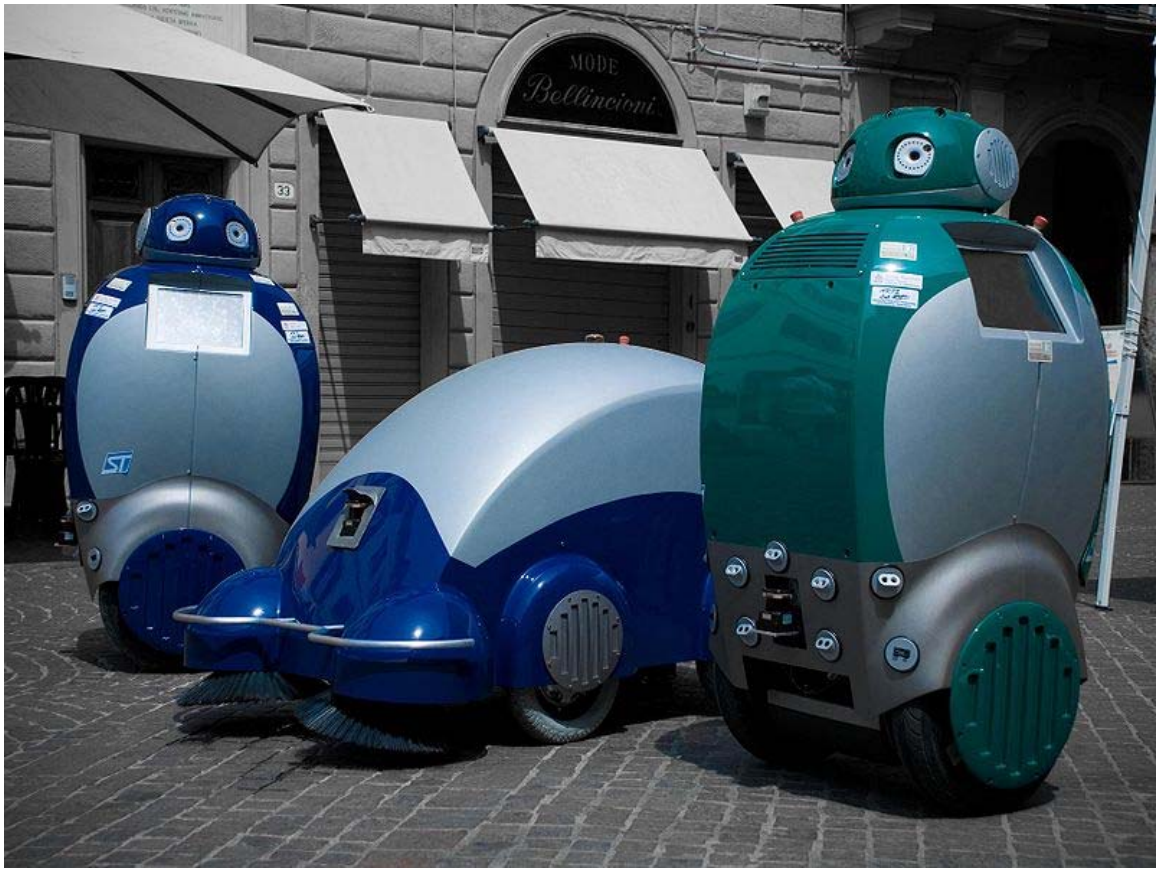
Dustbot



Launch year 2009

Dustbot is a robot that can collect garbage from homes. It can be summoned by phone call or SMS, and uses GPS to automatically make its way to the customer, collect the rubbish, and take it to a dustbin. In addition, the Dustbots carry environmental sensors to monitor the pollution levels over, for example, a pedestrian area. Prototypes have been tested in Italy and Sweden and Ireland, and it is due for launch in 2009. The Dustbot project is funded by the European Commission.

Testing and operation



Dustbot is allegedly the world's first robot that comes to take away rubbish from a residence upon request. It can be summoned to an address by phone or SMS at any time of the day. The caller's position is calculated and the Dustbot is dispatched. When the robot arrives "you use the robots display board to enter what sort of trash it is and then the robot carries it to a dust bin", said Matteo Reggente, one of the DustBot scientists. The DustBot then opens its bin, collects the trash and takes it to a designated area.

The Dustbot system, consisting of the DustCart and the DustClean robots, is designed to work in tight urban areas where large trucks find it difficult to operate, such as old European cities. It can work in narrow streets which are difficult for large refuse trucks to negotiate. The DustClean robot can also sweep, vacuum-clean and measure pollution.

Technical

The garbage bin of the Dustcart robot has a capacity of 40 kg.

Dustbot uses different localisation systems and uses GPS navigation combined with pre-loaded maps. It uses a gyroscope to keep it upright, and has sensors to avoid collisions with static and dynamic obstacles.

It is able to monitor pollution through a number of air quality sensors., and can warn if the levels are too high. The key idea is to exploit robots that are primarily used for something else for pollution monitoring and/or detection of poisonous gases. This is especially important in the case of gases that humans cannot sense or when long-term exposure to slightly increased concentrations needs to be verified. The distribution of gases is modelled using statistical methods.

The Dustbot system communicates via a wireless network connected to both GPS and internet.

Chapter- 3

Domestic Robots for Outdoor

Lawn mower

A typical modern gasoline-powered walk-behind mower.

A **lawn mower** is a machine that uses a revolving blade or blades to cut a lawn at an even length.

Lawn mowers employing a blade that rotates about a vertical axis are known as *rotary* mowers, while those employing a blade assembly that rotates about a horizontal axis are known as *cylinder* or *reel* mowers.

Many different designs have been made, each suited to a particular purpose. The smallest types, pushed by a human, are suitable for small residential lawns and gardens, while larger, self-contained, ride-on mowers are suitable for large lawns, and the largest, multi-gang mowers pulled behind a tractor, are designed for large expanses of grass such as golf courses and municipal parks.

A riding mower or ride-on mower.

A tractor-pulled mower.

History

Introduction: The lawnmower is defined as a hand-operated or power-operated machine with rotary blades for cutting grass on lawns. To make the process of cutting grass easier over the ages, many individuals have added onto the original design to add speed, efficiency, and power. Before the first lawnmower was invented, the use of grazing animals and hand held clippers were the only way of having a kept lawn.

Cylinder mowers

The first lawn mower was invented by Edwin Budding in 1827 in Thrupp, just outside Stroud, in Gloucestershire. Budding's mower was designed primarily to cut the lawn on sports grounds and expensive gardens, as a superior alternative to the scythe, and was patented in 1830. It took ten more years and further innovations to create a machine that could be worked by animals, and sixty years before a steam-powered lawn mower was built. The first machine produced was 19in in width with a frame made of wrought iron. The mower was pushed from behind with the motive power coming from the rear land roller which drove gears to transfer the drive to the knives on the cutting cylinder; the ratio was 16:1. There was another roller placed in between the cutting cylinder and the land roller which was adjustable to alter the height of cut. On cutting, the grass clippings were hurled forward into a tray like box. It was soon realized, however, that an extra handle was needed in front of the machine which could be used to help pull it along. Two of the earliest Budding machines sold went to Regent's Park Zoological Gardens in London and the Oxford Colleges. In an agreement between John Ferrabee and Edwin

Budding dated May 18, 1830, Ferrabee paid the costs of development, obtained letters of patent and acquired rights to manufacture, sell and license other manufacturers in the production of lawn mowers.

These early machines were all made of cast iron and featured a large rear roller with a cutting cylinder (reel) in the front. Cast iron gear wheels transmitted power from the rear roller to the cutting cylinder. Overall, these machines were remarkably similar to modern mowers. Without patent, Budding and Ferrabee were shrewd enough to allow other companies to build copies of their mower under license, the most successful of these being Ransomes of Ipswich which began making mowers as early as 1832. In the middle of the decade, Thomas Green and Son of Leeds introduced a mower called the Silens Messor (meaning silent cutter), which used chain to transmit power from the rear roller to the cutting cylinder. These machines were lighter and quieter than the gear driven machines that preceded them, although they were slightly more expensive. Thomas Green produced the first chain-driven mower in 1859.

A cylinder (reel) mower from 1888 showing a fixed cutting blade in front of the rear roller and wheel-driven rotary blades

Thomas Green produced the first chain-driven mower in 1859. Manufacture of lawn mowers began in the 1860s. By 1862, Farrabee's company was making eight models in various roller sizes. He manufactured over 5000 machines until production ceased in 1863. The first United States patent for a reel lawn mower was granted to Amariah Hills on January 12, 1868. . In 1870, Elwood McGuire of Richmond, Indiana designed a human-pushed lawn mower, which was very lightweight and a commercial success. John Burr, an African American, patented an improved rotary-blade lawn mower in 1899, with the wheel placement altered for better performance. Amariah Hills went on to found the Archimedean Lawn Mower Co. in 1871. Around 1900, one of the best known English machines was the Ransomes' Automaton, available in chain- or gear-driven models. JP Engineering of Leicester, founded after World War I, produced a range of very popular chain driven mowers. About this time, an operator could ride behind animals that pulled the large machines. These were the first riding mowers. In 1902, Ransomes produced the first commercially available mower powered by an internal combustion gasoline engine. In the United States, gasoline powered lawn mowers were first manufactured in 1919 by Colonel Edwin George. .

The rise in popularity of lawn sports helped prompt the spread of the invention. Lawn mowers became a more efficient alternative to the scythe and domesticated grazing animals. James Sumner of Lancashire patented the first steam-powered lawn mower in 1893. His machine burned petrol and/or paraffin (kerosene) as fuel. These were heavy machines that took several hours to warm up to operating pressure. After numerous advances, the machines were sold by the Stott Fertilizer and Insecticide Company of Manchester and, later, Sumner took over sales. The company they controlled was called the Leyland Steam Motor Company. Numerous manufacturers entered the field with petrol (gasoline)-driven mowers after the turn of the century. The first grass boxes were flat trays but took their present shape in the 1860s. The roller-drive lawn mower has changed very little since around 1930. Gang mowers, those with multiple sets of blades, were built in the United States in 1919 by a Mister Worthington. His company was taken over by the Jacobsen Corporation, but his name is still cast on the frames of their gang units.

Rotary mowers

Rotary mowers were not developed until engines were small enough and powerful enough to run the blades at a high speed. Many people experimented with rotary blades in the late 1920s and early 1930s, and Power Specialties Ltd. introduced a gasoline-powered rotary mower. One company that produced rotary mowers commercially was the Victa company, starting in 1952: these mowers were lighter and easier to use than the mowers that came before. The first Victa mowers were made at Mortlake by local resident Mervyn Victor Richardson. He made the first out of scrap in his garage and then moved to a shed behind St Mary's Church of England, where the first Victa mowers were manufactured and went on sale on 20 September 1952. The new company, Victa Lawnmowers Pty Ltd, was incorporated on 13 February 1953. The venture was so successful that by 1958 the company moved to much larger premises in Parramatta Road, Concord and then to Milperra.

Types of lawn mowers

By rotation

Cylinder (UK) or Reel (US) mowers

A Modern version of the Reel Mower, manufactured by Fiskars.

A battery powered version of the Reel/Cylinder Mower, manufactured by CEL

The cylinder mower carries a fixed, horizontal cutting blade at the desired height of cut. Over this is a fast-spinning reel of blades which force the grass past the cutting bar. Each blade in the blade cylinder forms a helix around the reel axis, and the set of spinning blades describes a cylinder.

Of all the mowers, a properly adjusted cylinder mower makes the cleanest cut of the grass, and this allows the grass to heal more quickly. The cutting action is often likened to that of scissors; however, it is not necessary for the blades of the spinning cylinder to contact the horizontal cutting bar. If the gap between the blades is less than the thickness of the grass, a clean cut can still be made.

There are many variants of the cylinder mower. Push mowers (illustrated) have no motor and are used on small lawns. As the mower is pushed along, the wheels drive gears which rapidly spin the reel. Typical cutting widths are 12 to 20 inches (510 mm).

The basic push mower mechanism is also used in gangs towed behind a tractor. The individual mowers are arranged in a vee behind the tractor with each mower's track slightly overlapping that of the mower in front of it. Gang mowers are used over large areas of turf such as sports fields or parks.

A gasoline engine or electric motor can be added to a reel mower to power the reel, the wheels, or both. A typical arrangement for residential lawns has the motor spinning the reel while the operator pushes the mower along. The electric models can be corded or cordless. Some variants have only 3 blades in a reel spinning at great speed, and these models can cut grass which has grown too long for ordinary push mowers. One type of reel mower, now largely obsolete, was a powered version of the traditional side wheel push mower and was used on residential lawns. An internal combustion engine sat atop the reel housing and drove the wheels, usually though a belt. The wheels in turn drove the reel, as in the push mower.

Greens (roller) mowers are used for the precision cutting of golf greens. The reel is followed by a large roller which smooths the freshly cut lawn and minimizes wheel marks. Due to the weight, the engine also propels the mower. Much smaller and lighter variants of the roller mower are sometimes used for small patches of ornamental lawns around flower beds, and these have no engine.

Riding reel mowers are also produced. Typically, the cutting reels are ahead of the vehicle's main wheels, so that the grass can be cut before the wheels push the grass over onto the ground. The reels are often hydraulically powered.

A rotary mower (viewed from underneath), with a mulching blade that rotates around the center.

Rotary mowers

A rotary mower rotates about a vertical axis.

By energy source

Gasoline (petrol)

Most rotary push mowers are powered by internal combustion engines. Such engines can be either two-stroke or four-stroke cycle engines, running on gasoline (petrol) or other liquid fuels. Internal combustion engines used with lawn mowers normally have only one cylinder. Power generally ranges from two to seven horsepower (1.5 to 6.75 kW). The engines are usually carbureted and require a manual pull crank to start them, although electric starting is offered on some models. Some mowers have a throttle control on the handlebar with which the operator can adjust the engine speed. Other mowers have a fixed, pre-set engine speed. Gasoline mowers have the advantages over electric mowers of greater power and distance range. However, they create substantial pollution and their engines require periodic maintenance such as cleaning or replacement of the spark plug and air filter.

Electric

Electric mowers are further subdivided into corded and cordless electric models. Both are relatively quiet, typically producing less than 75 decibels, while a gasoline lawn mower can be as loud as 95 decibels or more. This kind of mower can also be safer to operate as they come equipped with a dead man's switch to immediately stop the motor when it is not being operated.

Corded electric

Electric rotary lawn mower, with rear grass catcher (note the red cord attached at the handle).

Corded electric mowers are limited in range by their trailing power cord, which may limit their use with lawns extending outward more than 100-150 feet from the nearest available power outlet. There is the additional hazard with these machines of accidentally mowing over the power cable, which stops the mower and may put users at risk of receiving a dangerous electric shock. Installing a residual-current device (GFCI) on the outlet may reduce the shock risk. On the United States market as of summer 2008, a corded electric mower from a respectable manufacturer costs about the same as an entry-level internal-

combustion mower ($150–200), with significantly higher reliability, significantly lower cost of ownership, and a significantly reduced carbon footprint.

Cordless electric

Cordless electric mowers are powered by a variable number (typically 1-4) of 12 volt rechargeable batteries. Typically more batteries mean more run time and/or power. Batteries can be in the interior of the lawn mower or on the outside. If on the outside the drained batteries can be replaced with recharged batteries. Cordless mowers have the maneuverability of a gasoline powered mower and the environmental friendliness of a corded electric but are more expensive and come in fewer models (particularly self-propelling) than either.

Other Notable Types

Hover mower (*underside view*).

Hover mowers are powered rotary push lawn mowers that use a turbine above the spinning blades to drive air downwards, thereby creating an air cushion that lifts the mower above the ground. The operator can then easily move the mower as it floats over the grass. Hover mowers are necessarily light in order to achieve the air cushion and typically have plastic bodies with an electric motor. The most significant downside,

however, is the cumbersome usability in rough terrain or on the edges of lawns, as the lifting air-cushion is destroyed by wide gaps between the chassis and the ground.

Robotic mower.

A **robotic mower** is contained by a border wire around the lawn that defines the area to be mowed. The robot uses this wire to locate the boundary of the area to be trimmed and in some cases to locate a recharging dock. Robotic mowers are capable of maintaining up to 5 acres (20,000 m^2) of grass. Robotic lawn mowers are increasingly sophisticated, are usually self-docking and contain rain sensors, nearly eliminating human interaction for mowing grass. Multiple robotic mowers can be used to mow an even larger area.

A Zero-turn mower an eXmark lazer Z mower on a campus.

Riding mowers (U.S.) or **ride-on mowers** (U.K.) are a popular alternative for large lawns. The operator is provided with a seat and controls on the mower and literally 'rides' on the machine. Most use the horizontal rotating blade system, though usually with multiple blades.

A common form of ride-on mower is the **lawn tractor**. These are usually designed to resemble a small agricultural tractor, with the cutting deck mounted amidships between the front and rear axles.

The drives for these mowers are in several categories. The most common transmission for tractors is a manual transmission. The second most common transmission type is a form

of continuously variable transmission called the hydrostatic transmission. These transmissions take several forms, from pumps driving separate motors, which may incorporate a gear reduction, to fully integrated units containing a pump, motor and gear reduction. Hydrostatic transmissions are more expensive than mechanical transmissions but they are easier to use and can transmit greater torque to the wheels as compared to a typical mechanical transmission. The least common drive type, and the most expensive, is electric.

There have been a number of attempts to replace hydrostatic transmissions with a lower cost alternative, but these attempts, which include variable belt types (e.g., MTD's Auto Drive) and toroidal, have various performance or perception problems that has caused their market life to be short or their market penetration to be limited.

Riding lawnmowers can often mount other devices such as rototillers/rotavators, snowplows, snowblowers, yard vacuums, occasionally even front buckets or fork-lift tines.

The deck of a rotary mower is typically made of steel. Lighter steel is used on less expensive models, and heavier steel on more expensive models for durability. Other deck materials include aluminum, which does not rust and is a staple of higher priced mowers, and hard composite plastic, which does not rust and is lighter and less expensive than aluminum. Electric mowers typically have a plastic deck.

Riding mowers typically have an opening in the side or rear of the housing where the cut grass is expelled. Some have a grass catcher attachment at the opening to bag the grass clippings. Special mulching blades are available for rotary mowers. The blade is designed to keep the clippings circulating underneath the mower until the clippings are chopped quite small. Other designs have twin blades to mulch the clippings to small pieces. This function has the advantages of forgoing the additional work collecting and disposing grass clippings while reducing lawn waste in such a way that also creates convenient compost for the lawn, forgoing the expense of fertilizer.

Mower manufacturers market their mowers as side discharge, 2-in-1, meaning bagging and mulching or side discharging and mulching, and 3-in-1, meaning bagging, mulching, and side discharge. Most 2-in-1 bagging and mulching mowers require a separate attachment to discharge grass onto the lawn. Some side discharge mower manufacturers also sell separate "mulching plates" that will cover the opening on the side discharge mower and, in combination with the proper blades, will convert the mower to a mulching mower. These conversions are impractical when compared with 2- or 3-in-1 mowers which can be converted in the field in seconds. There are two types of bagging mowers. A rear bag mower features an opening on the back of the mower through which the grass is expelled into the bag. Hi-vac mowers have a tunnel that extends from the side discharge to the bag. Hi-vac is also the type of grass collection used on riding lawn mowers and lawn tractors and is considered more efficient. Mulching and bagging mowers are not well suited to long grass or thick weeds.

Rotary mowers with internal combustion engines come in three price ranges. Low priced mowers use older technology, smaller motors, and lighter steel decks. These mowers are targeted at the residential market and typically price is the most important selling point. These mowers are sold through large discount and home improvement stores, range between $100–400 on the US market, and have a typical service life of 7–10 years. Higher priced mowers are also primarily targeted at residential customers. These mowers have more features and often have heavier steel, composite plastic or aluminum decks. Most of these mowers are sold through independent dealers who also service the equipment and cost between $200 and $1000. These mowers will last as long as twenty years given regular maintenance. Commercial grade mowers are the most expensive rotary mowers. They are "targeted" at grounds maintenance companies and other professionals, but are commonly sold to home owners as well. These mowers feature the latest technology and include features such as disk drive, oil filters, and very heavy steel and, more often, aluminum decks. These mowers are sold through independent dealers who service the product and, with regular maintenance, they have a service life far beyond twenty years. A commercial grade mower typically costs from $4,000 to as much as $90,000.

Professional grass-cutting equipment (used by large establishments such as universities, sports stadiums and local authorities) usually take the form of much larger, dedicated, ride-on platforms or attachments that can be mounted on, or behind, a standard tractor unit (a "gang-mower"). Either type may use rotating-blade or cylindrical-blade type cutters, although high-quality mowed surfaces demand the latter. Wide-area mowers (WAMs) are commercial grade mowers which have decks extended to either side, many to 12 feet (3.7 m). These extensions can be lowered for large area mowing or raised to decrease the mower's width and allow for easy transport on city roads or trailers.

Safety issues

Rotary mowers can throw out debris with tremendous force. In the US, over 80,000 people per year are hospitalized due to mower accidents. The vast majority of these injuries could be avoided by wearing footwear while mowing. The American Academy of Pediatrics recommends that children be at least 12 years old before they are allowed to mow.

Environmental impact

A 2001 study showed that some mowers emit the same amount of pollution (emissions other than carbon dioxide) in one hour as driving a 1992 model car for 650 miles (1,050 km). Another estimate puts the amount of pollution from a lawn mower at four times the amount from a car, per hour. Beginning in 2011, the United States Environmental Protection Agency has set standards for lawn equipment emissions and expects a reduction of at least 35%.

Mowers also cause significant noise pollution, and may cause hearing loss if used without hearing protection.

Chapter- 4

Domestic Robots for Entertainment

AIBO

The AIBO ERS-7

AIBO (**A**rtificial **I**ntelligence ro**BO**t, homonymous with "pal" or "partner" in Japanese) was one of several types of robotic pets designed and manufactured by Sony; there have been several different models since their introduction on May 11, 1999. AIBO was discontinued in 2006.

Overview

Being able to walk, "see" its environment via camera and recognize spoken commands in Spanish and English; AIBO robotic pets are considered to be autonomous robots since they are able to learn and mature based on external stimuli from their owner or environment, or from other AIBOs. Artist Hajime Sorayama created the initial designs for the AIBO.

The original designs are part of the permanent collections of MoMA and the Smithsonian Institution. The design won Sony and artist Sorayama the highest design award that may be conferred by Japan. On January 26, 2006 Sony announced that it would discontinue AIBO and several other products as of March, 2006 in Sony's effort to make the company more profitable. It also stopped development of the QRIO robot. AIBO will still be supported until 2013 (ERS7 model) and AIBO technology will continue to be developed for use in other consumer products.

AIBO playing with kids

AIBOware (the name is a trademark of Sony corporation), is the title given to the software the AIBO runs on its pink Memory Stick. The *Life* AIBOware allows the robot to be raised from pup to fully grown adult while going through various stages of development as its owner interacts with it. The *Explorer* AIBOware allows the owner to interact with a fully mature robot able to understand (though not necessarily willing to obey) 100 voice commands. Without the AIBOware, the AIBO will run in what is called "clinic mode" and can only perform basic actions.

Many AIBO owners enjoy teaching their pets new behaviors by reprogramming them (in Sony's special 'R-CODE' language). However, in October 2001, Sony sent a cease-and-desist notice to the webmaster of Aibopet, demanding that he stop distributing code that was retrieved by bypassing the copy protection mechanisms of the robot. Eventually, in the face of many outraged AIBO owners, Sony released a programmer's kit for 'non-commercial' use. The kit has now been expanded into three distinct tools: R-CODE, AIBO Remote Framework, and the OPEN-R SDK. These three tools are combined under the name AIBO Software Development Environment. All of these tools are free to download and can be used for commercial or non-commercial use (Except for the OPEN-R SDK, which is specifically for non-commercial use). Since the first release of OPEN-R, several AIBO programming tools have been developed by university labs, including URBI , Tekkotsu , Pyro and AiBO+. The Open-R and gcc based toolchain has been

updated by the community to use gcc 4.1.2, binutils 2.17 and newlib 2.15. The packaged version of the old and updated Aibo toolchain is available for Ubuntu in a PPA.

AIBO's complete vision system uses the SIFT algorithm, to recognise its charging station. The newest versions are equipped with a Wi-Fi connection, allowing them to send the pictures they take via email which led to the Roblog.

AIBO's sounds were programmed by Japanese DJ/avant-garde composer Nobukazu Takemura, fusing mechanic and organic concepts. The bodies of the "3x" series (Latte and Macaron, the round-headed AIBOs released in 2001) were designed by visual artist Katsura Moshino.

RoboCup

The AIBO has seen use as an inexpensive platform for artificial intelligence research, because it integrates a computer, vision system, and articulators in a package vastly cheaper than conventional research robots. The RoboCup autonomous soccer competition had a "RoboCup Four-Legged Robot Soccer League" in which numerous institutions from around the world would participate. Competitors would program a team of AIBO robots to play games of autonomous robot soccer against other competing teams. The Four-Legged League ran from 1999 to 2008, although in the final year, many big-name universities did not compete as they had moved to the new NAO platform. The University of New South Wales was the most successful team in the League, making the final six times and winning three times.

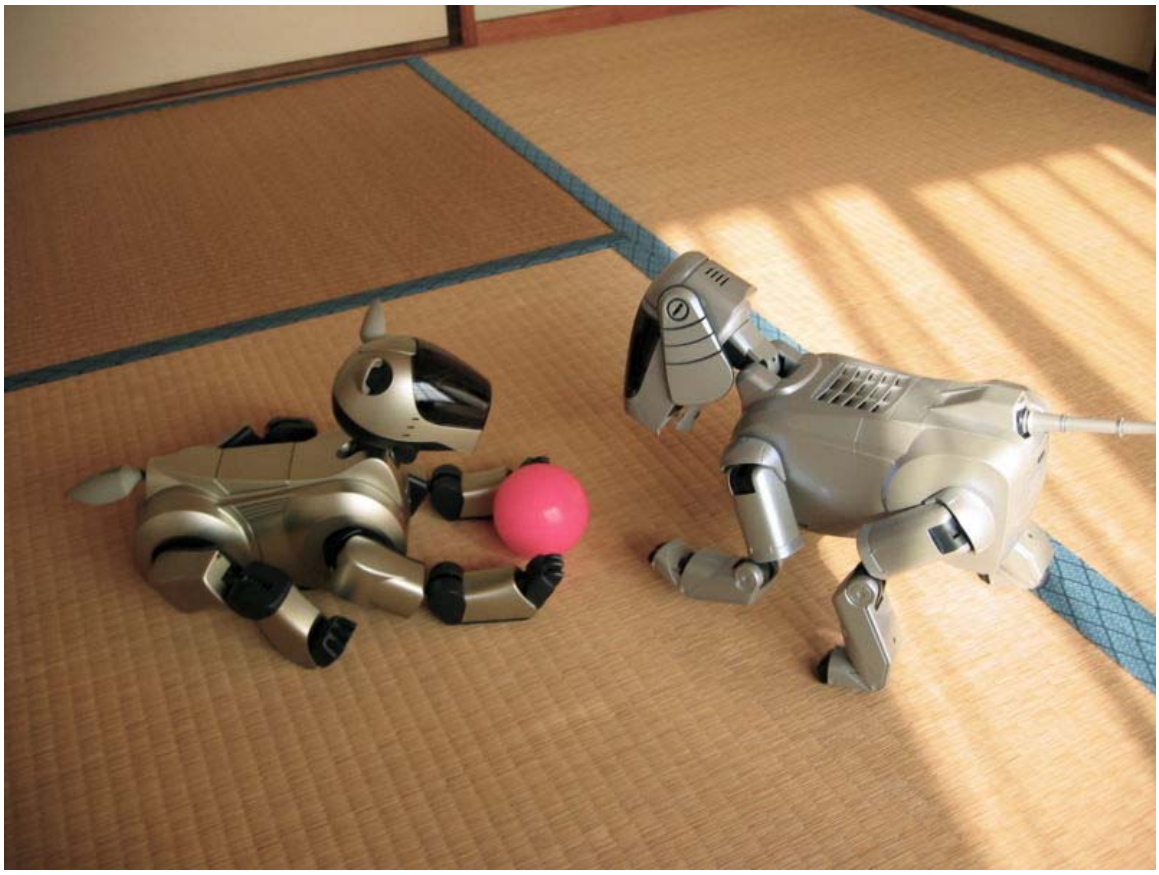
International AIBO Convention

The International AIBO Convention takes place every year at Sony Robotics Tower in the Shinjuku prefecture. The first convention took place in 1999, on May 15. It was then set to May 2 to May 4. The 2009 convention, being in its tenth year, set attendance records. The convention usually features AIBO advertisements, free posters, free accessories, freeware/open-source downloads, an acoustic performance from best friends Mark Linn-Baker and Larry Sweeney, and "AIBO Shows".

Breed lineage

After model name: body color choices; release date; units sold.

First generation models



AIBO models ERS-210 (left) and ERS-111 (right)

- ERS-110: silver; began sales 1 June 1999 for delivery in August; limited production of 3,000 for Japan and 2,000 for the USA
- ERS-111: grey and black; November 1999; 60,000 (estimated)

Second generation models

- ERS-210: black, silver, gold, red, blue, green, white (3 hues), champagne, etc.; 2001
- ERS-210A: several colors; 2002
- ERS-220: silver; 2002 (also available as a conversion kit for the ERS-210)
- ERS-311 "Latte": cream; 2001
- ERS-311b "Latte": cream; 2002
- ERS-312 "Macaron": black; 2001
- ERS-31L "Pug": brown; 2002
- ERS-210A: cyber blue; 2003

Estimated sales for all second generation models: 60,000

Third Generation models

- ERS-7: white; November 2003
- ERS-7M2: white and black; November 2004
- ERS-7M3: white, black, and champagne brown (called honey brown in Japan); October 2005

Estimated sales for all third generation models: 40,000 to 50,000

i-Cybie

The i-Cybie.

i-Cybie with walk up charger.

i-Cybie is a robotic pet that resembles a dog. It was manufactured by Silverlit Electronics. The i-Cybie robot responds to sound, touch, voice commands via remote control. Although i-Cybie does possess a limited amount of artificial intelligence, programming is not easily modifiable by the end-user, and it is not capable of autonomous learning. The i-Cybie was one of the first robot pets on the market that could power itself via its Walk-Up-Charger.

Sensors

- Motion sensors allow i-Cybie to detect movement around it.
- Obstacle sensors are used to navigate as it walks and to avoid bumping into objects.
- An i-Cybie robot can interact with other i-Cybie robots using a built-in IR communicator.

- Sensors on its help the i-Cybie react to touch.
- Sound sensors allow i-Cybie respond to voice commands to *clap* commands. Voice commands require training. *Clap* commands which do not require training.
- Edge detectors help prevent falls, but there have been reports that this feature is not necessarily reliable & was never an advertised feature. This is because many do not read the instructions so they do not know how to enable it.
- Tilt sensors allow it to detect when it has fallen down.
- Light sensors let him detect changes in ambient light in your room.

Interestingly, I-cybie has surprisingly good directional hearing: In one mode, I-cybie will "startle" at a normal to loud sudden sound (a clap or sharp, quick sound) then walk in the direction the sound came from. This is a pretty advanced trick for a "toy" robot, especially one manufactured beginning in 1999-2000.

Tricks That I-Cybie is Capable of Performing Without User-Modifications

- Take a bow
- Sit down
- Wag tail
- Stay
- Guard
- Scratch ear
- Give me your paw
- Pee
- Head stand
- Dance
- Beg

Voice Commands

The i-Cybie can be trained to respond to voice. To activate voice control and issue a command one must put I-cybie in "Listening" mode, then speak the command. I-cybie's eyes will glow and flash indicating that he is: in listening lode, that he is waiting for a command, then whether he has understood what was spoken or not. If he recognizes the word, he will then perform the action. There are 8 different voice commands. One can choose what word or phrase i-Cybie will respond to for each trick. The voice control interface is *speaker dependent* so i-Cybie will only respond to your voice alone, not the voices of others.

Clap Commands

Clap commands are executed as a series of claps and pauses. For example, the *Stay* command is activated by clapping once, pausing, and clapping three more times. The *sit down* command is clap twice and pause and then clap again.

Personality

The i-Cybie has five distinct simulated moods:

- Happy
- Hyper
- Sad
- Sleepy
- Sick

Each one of these moods is expressed with a distinct body position and eye pattern in response to external stimulus.

Expandibility

Silverlit Electronics had a Downloader kit that let you add an expansion cartridge to change i-cybie's mood & even sounds. Unfortunately,the Downloader accessory and the required cartridge are now exceedingly rare.

Additionally, the newer versions of I-cybie came with a walk-up charger that let I-cybie charge his own batteries. The charger came with a cartridge that modified the firmware of the robot to take advantage of the charger unit. The cartridge could be used on older I-cybies to update their firmware so that they too could use the walk-up charger.

It is possible to hack the I-cybie as well, but it requires the removal and modification of the the robot's outer shell and soldering of new electronics onto the original electronics board. The hack is not trivial and it is very possible to ruin the dog if done incorrectly.

History

The i-Cybie was created by a Hong Kong company Silverlit Electronics and released to toy fairs in 2000. It was originally marketed and distributed by Tiger Electronics in 2001 but due to world market problems at the time of release & a battery problem the robot did not do well. Tiger was later acquired by Hasbro Toys. The product was relaunched in 2005 by Silverlit Electronics and was distributed by Outrageous. X-Cybie, a fur version, was said to be launched in 2006, however about then, all i-Cybies were discontinued. i-Cybie is now classed as discontinued; there will not be any future upgrades or accessories.

i-Cybie firmware

When Tiger Electronics got the marketing and distributing rights they agreed with Silverlit Electronics to change the robot's features & overall look as i-Cybie looked more like SonyAibo. The i-Cybie firmware was designed by Micom tech HK on behalf of Tiger. Recent research by i-Cybie Fans has determined that Hasbro owns the firmware rights, having acquired Tiger.

i-Cybie Problems

Batteries

Tiger Electronics placed a small sticker on the i-Cybie quick start card that told the user the first charge of i-Cybie's Battery is 10 hours. This damaged many batteries, making the running time of the robot less than one hour in some cases. The normal charging time is three hours. Silverlit Electronics released a new long lasting battery in 2004 & in 2005/6 and also released the "Smart Timer"- a small black device designed to stop the user from overcharging the battery.

A company called "Strikealite" in the U.K. currently offers new batteries and a smart-charger for the I-cybie: one rated at 2100mAh and another at 1200mAh. One can buy their products on E-Bay or from the Strikealite webpage. Be sure to buy a charger for the battery that is compatible with your home country's electrical wall outlet system. Also, the wire connector on the I-cybie unit is an uncommon form, so if one intends to use their own charger, they should be aware that they may have a hard time finding an appropriate connector to interface with the battery.

Mechanical

Legs

i-Cybie users have reported problems with the robot's legs, some coming loose & no longer working. At present the only known way to fix this problem is by replacing the leg, which only requires the user to open the robot, unplug the leg & replace it with a new one.

Head

It has been reported that the encoder on the motor for the left/ right turning of the head can become mis-aligned. This results in the motor attempting to turn the head too far in one direction or the other. Fortunately, all the motors in the I-cybie have a clutch system that protects from over-torquing and damaging the mechanics. Therefore, while the clicking sound of the head trying to move can be alarming or irritating, the unit is not actually being damaged. That said, since the I-cybie's internal electronics will not know the "real" status of how the head is positioned, some of I-cybie's built-in tricks will likely fail; standing on his head, etc.

Super i-Cybie

The Super i-Cybie "i-Cybie Hack" project is a hardware hack that adds a computer port onto the robot's computer system. Several experienced i-Cybie owners with programming skills have banded together to try to drastically enhance the i-Cybie's capabilities.

QRIO

Sony QRIO

Presentation of the Sony Qrio Robot at the RoboCup 2004.

Manufacturer	Sony
Year of creation	2003

QRIO ("**Q**uest for cu**RIO**sity", originally named Sony Dream Robot or SDR) was to be a bipedal humanoid entertainment robot developed and marketed (but never sold) by Sony to follow up on the success of its AIBO toy. QRIO stood approximately 0.6 m (2 feet) tall and weighed 7.3 kg (16 pounds). QRIO's slogan was "*Makes life fun, makes you happy!*"

Presentation of the Sony Qrio Robot at the RoboCup 2004.

On January 26, 2006, on the same day as it announced its discontinuation of AIBO and other products, Sony announced that it would stop development of QRIO. Before it was cancelled, QRIO was reported to be going through numerous development, testing and scalability phases, with the intent of becoming commercially available within three or four years.

Development

The QRIO prototypes were developed and manufactured by Sony Intelligence Dynamics Laboratory, Inc. The number of these prototypes in existence is unknown. Up to ten QRIO have been seen performing a dance routine together; this was confirmed by a Sony

representative at the Museum of Science in Boston, MA on January 22, 2006. Many videos of this can be found on the web.

Four fourth-generation QRIO prototype robots were featured dancing in the *Hell Yes* music video by recording artist Beck. These prototypes lacked a third camera in the center of the forehead and the improved hands and wrists which were added to later prototypes. It took programmers three weeks to program their choreography.

QRIO is capable of voice and face recognition, making it able to remember people as well as their likes and dislikes. A video on QRIO's website shows it speaking with several children. QRIO can run at 23 cm/s, and is credited in Guinness World Records (2005 edition) as being the first bipedal robot capable of running (which it defines as moving while both legs are off the ground at the same time). The 4th generation QRIO's internal battery lasts about 1 hour.

Pleo

Pleo Robot

Pleo is an animatronic dinosaur toy designed to emulate the appearance and (imagined) behavior of a week-old baby *Camarasaurus*. It was designed by Caleb Chung, the co-creator of the Furby, Chung's company Ugobe sold pleo and was manufactured by Jetta. Chung selected this species of dinosaur because its body shape, stocky head, and relatively large cranium made it ideal for concealing the sensors and motors needed for lifelike animation. According to Ugobe, each Pleo would "learn" from its experiences and environment through a sophisticated artificial intelligence and develop an individual personality.

Pleo was unveiled on February 7, 2006 at the DEMO Conference in Scottsdale, Arizona and was expected to come on the Indian and American markets around Fall 2007. Pleo shipments started on December 5, 2007.

In April 2009, Ugobe laid off all of its employees and filed for bankruptcy.

On June 8, 2009 Jetta announced it is re-launching Pleo and are continuing the line including accessories such as the vital battery and battery charger components.

Pleo is now owned by Innvo Labs Corporations.The company’s products, known as Life Forms, intend to blur the line between technology and life by integrating three disciplines—organic articulation, sensory response, and autonomous behavior. Innvo Labs aims to transfer inanimate objects into lifelike creatures by using robotics.

Overview

Pleo was engineered by a group of robotics specialists, animators, technologists, scientists, biologists, and programmers. The design combined sensory, articulation, and neuronetics to create a lifelike appearance with organic movement and adaptable behaviors.

In developing Pleo, Ugobe noted the biological and neurological systems of the Camarasaurus, and "re-interpreted" those elements through hardware and software.

The robot is software-upgradeable via SD card or USB interfaces and original cost was $350 USD. Ugobe encouraged user modifications of the robot's firmware, provided links to 3rd party developed tools such as a graphical interface for home users called MySkit, and an API for programmers called a "PDK" (Pleo Developers Kit).

In a 2008 test of various animatronic animal toys in *Slate* magazine, the Pleo was the only contestant that was considered a success, whereas the remaining models of earlier or competing developers were mainly considered unnatural, creepy, or simply unconvincing.

Features

- camera-based vision system (for light detection and navigation)
- two microphones, binaural hearing
- beat detection (allows pleo to dance and listen to music).
- eight touch sensors (head, chin, shoulders, back, feet)
- four foot switches (surface detection)
- fourteen force-feedback sensors, one per joint
- orientation tilt sensor for body position
- infrared mouth sensor for object detection into mouth
- two-way infrared communication with other Pleos
- Mini-USB port for online downloads
- SD card slot for Pleo add-ons
- infrared detection for external objects
- 32-bit Atmel ARM7 microprocessor (main processor for Pleo)
    - 32-bit NXP Semiconductors ARM7 sub-processor (camera system, dedicated audio input processor)
    - four 8-bit processors (low-level motor control)

Ugobe bankruptcy

Beginning in December 2008, Pleoworld began to experience technical problems. By the Christmas holidays, Pleoworld was offline, including the user forums. After the holidays, both Pleoworld and Ugobe's official websites displayed updating website messages. Both sites returned sometime at the beginning of 2009. Ugobe official website updated its board of directors listing. Ugobe stated that the problems were due to the company's relocation but had not explained why the user forums have not been restored.

Wired News reported the company's outlook was not good, and it was struggling to save itself from extinction as it tried to raise new funding and keep its pipeline of products alive.

From November 2008, the company saw a host of top management departures, including two CEOs, moved its office in California, and pared down its marketing and Public Relations staff in an attempt to weather the current economic storm. (This may be the reason for Pleoworld's demise.) Emails to the company's media contact on its website bounced back. Phone calls to its corporate office were not answered.

In July 2008, Ugobe CEO Bob Christopher stepped down and former CFO Liz Gasper retook control of the company. Christopher said he left the company to move on to other ventures. Gasper had focused on cutting down the company's burn rate and finding new funding.

With the collapse of the United States credit environment, though, fund raising came to a halt. Meanwhile, the company's entire board of directors resigned before December, 2008, giving control of Ugobe back to the co-founders, said Swanson.

Ugobe also closed its Emeryville, California office and moved all operations to its other offices in Boise, Idaho. The company then had about twenty employees.

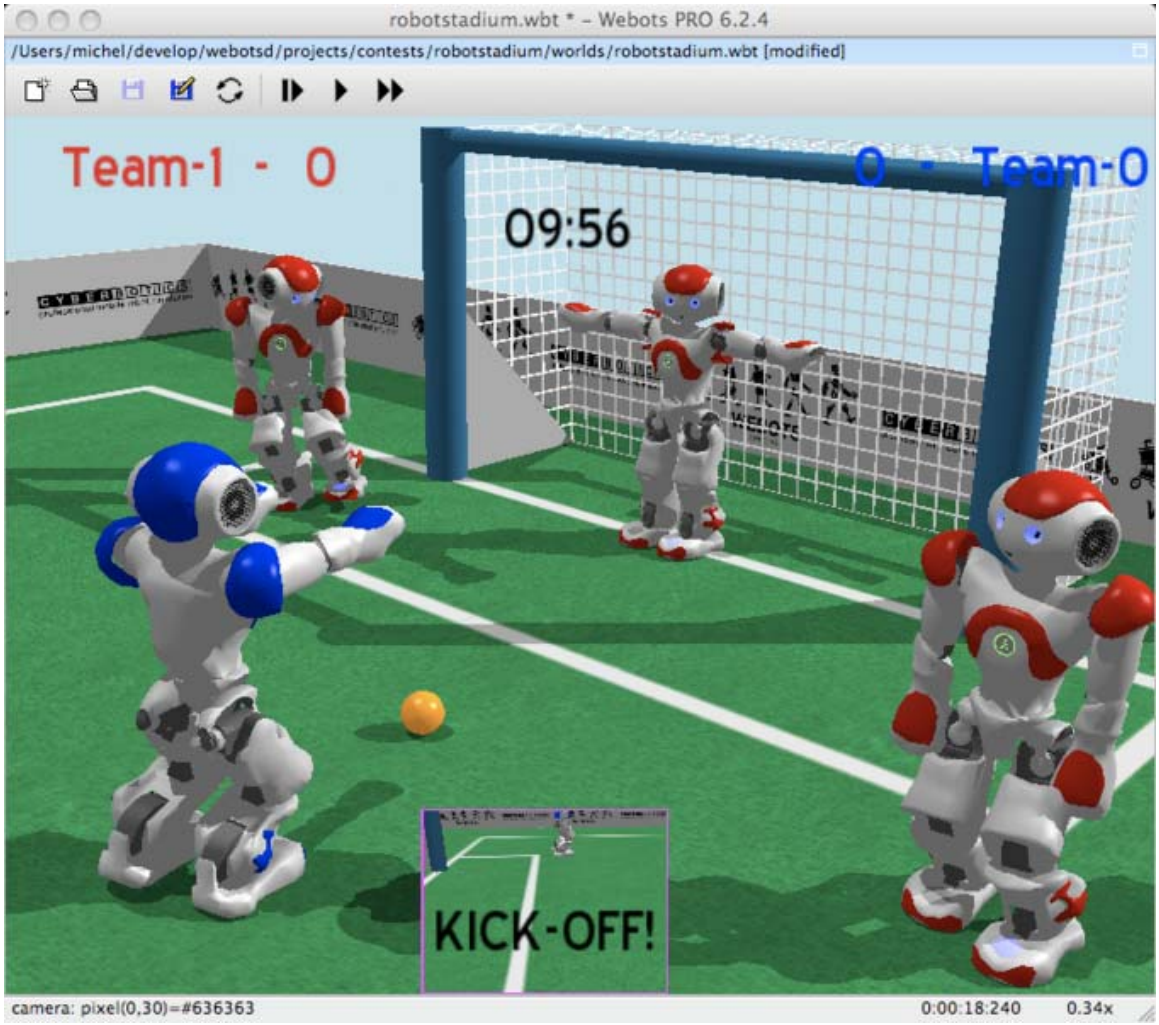
Gasper left the company, and original co-founder Caleb Chung found himself back in the hot seat. Chung did not respond to requests for an interview.

It had become extremely difficult for new Pleo owners or existing members of the website to access the official forums and Plogs. In the wake of these problems, a loyal fan has set up a forum for members to join to talk Pleo, get the latest Pleo news, and download firmware updates for Pleo.

On April 17, 2009 Ugobe filed chapter 7 bankruptcy, and halted the production of new Pleos.

On June 8, 2009 Jetta acquired Ugobe and Steve Ohler – the United States liaison for the company – said the company is firmly committed to re-launching Pleo and continuing the line including accessories such as the vital battery and charger components.

Nao (robot)



Nao robot in Webots RoboCup soccer simulation.

Nao (pronounced "now") is an autonomous, programmable and medium-sized humanoid robot, developed by the French company Aldebaran Robotics, a start-up headquartered in Paris. Project Nao was launched in 2005.

On August 15, 2007, Nao replaced the robot dog Aibo by Sony as the robot used in the Robocup ("Robot Soccer World Cup") Standard Platform League (SPL), an international robotics competition. The Nao was used in RoboCup 2008 and 2009, and the NaoV3R was chosen as the platform for the SPL at RoboCup 2010.

Nao Academics Edition is available for universities and laboratories for research and education purposes, projected for public distribution by 2011. In October of 2010, the University of Tokyo purchased 30 Nao robots to participate in research with their Nakumura Lab, with hopes of developing them into assistants.

In the Summer of 2010 Nao made global headlines with a synchronized dance routine at the Shanghai Expo.

Versions

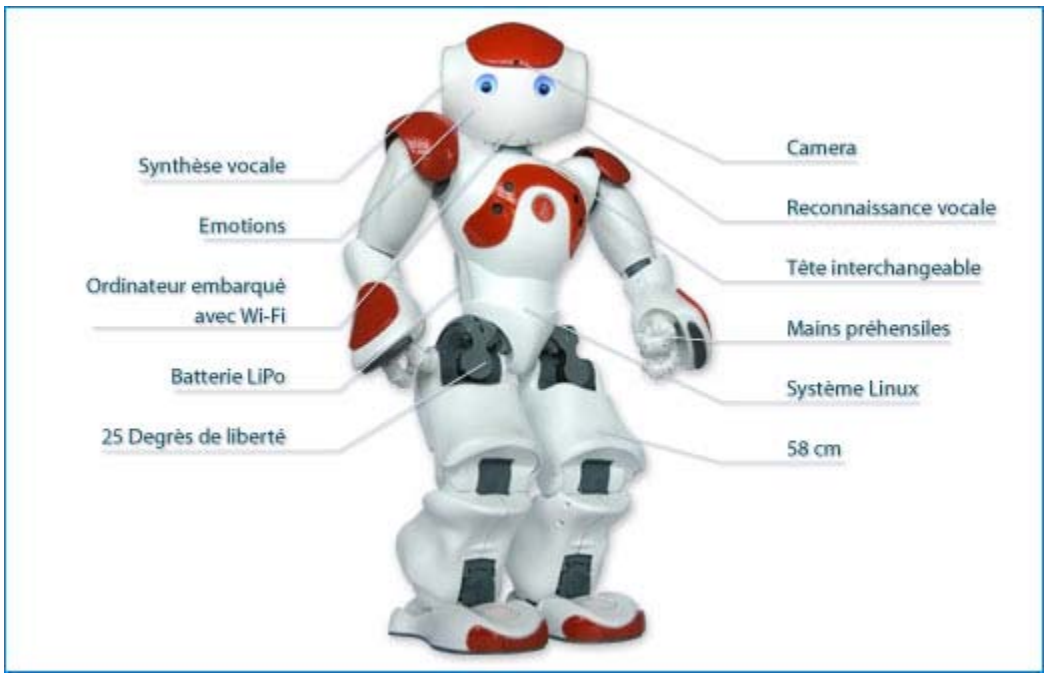


Diagram of Nao's functionability.

Six prototypes of Nao were designed:

- from January 2005 to March 2006 : AL-01, AL-02 and al.-03
- from September 2005 to July 2006 : AL-04
- from June 2006 to June 2007 : AL-05.a
- from May 2007 to December 2007 : AL-05.b

On March 2008, a first finalized version (Nao Robocup Edition) was released to the Robocup's contestants.

Technical Specifications	
Height	58 cm
Weight	4,3 kg
Autonomy	90 min. (constant walking)
Degrees of freedom	21 to 25
CPU	x86 AMD GEODE 500 MHz
Built-in OS	Linux
Compatible OS	Windows, MacOS, Linux

Programming languages	C++, C, Python, Urbi, .Net
Vision	Two CMOS 640 x 480 cameras
Connectivity	Ethernet, Wi-Fi

In late 2008, the Nao Academics Edition was released to the academics and education market (universities and companies).

A general public version is to be launched 2011/2012 .

Specifications

Robocup Edition has 21 degrees of freedom (DOF) while the *Academics Edition* has 25 DOF since it is built with two hands with gripping abilities. The figure of 25 for DOF is misleading as each leg has a "HipYawPitch" axis of movement that amounts to 1 DOF for the pelvis.

All versions feature an Inertial measurement unit and 4 Ultrasonic sensors that provide stability and positioning within space to Nao.

Nao also features a powerful multimedia system (4 microphones, 2 speakers, 2 CMOS cameras) for text-to-speech synthesis, sound localization or facial and shape recognition amongst various other abilities.

The package includes a dedicated programming software called *Aldebaran Choregraphe* and Nao is also compatible with Microsoft Robotics Studio, Cyberbotics Webots, and Gostai Urbi Studio.

Genibo

Genibo is a robotic dog produced by the Korean company Dasarobot of Dasatech.

GENIBO

The Genibo QD is an autonomous pet robot, similar in concept to Sony's 'ERS-7' Aibo, but was created to be much more dog like in appearance and behavior.

Modeled to resemble a bull terrier, the Genibo QD can identify itself and the surroundings using its sensors, camera, and voice commands and share feelings with the user. With input information, it forms 'Emotion/Mood/Intelligence/Character/Intimacy' to feature unique character and AI.

The Genibo QD is capable of understanding over 100 voice commands (such as "sit", "come here" and "do a headstand") and has the ability to praise or scold the dog using the touch sensors located on its head, back and flank. The dogs mood will change according to user interaction and can express happiness, pleasure, sadness, surprise, anger, boredom and sleepiness.

The Genibo QD comes with PC Control Manager software that allows you to see a live view of what the dog is seeing, take photos, create skits/dance routines, record voice memos, MP3 playback, and set alarms.

Genibo was originally released as a prototype in 2006 and was made available to the public in 2008 for about $1500 USD. The new 2009 Genibo QD robots come with English computer software and remote as well as the ability to understand English voice commands as where the previous models could only understand Korean.

Stats

Genibo Headstand.

W x L x H = 192mm x 334mm x 330mm
weight (inc Battery) = 1.6 kg
CPU = 32 bit RISC Proc
Battery = 7.4V Li-ion, 2,200 mAh
Charger adapter = 110 - 240V: 50 – 60 Hz (Universal Supply) output at 9V, 2.5A
Camera = 1.3M pixel, 1280 x 1024, Frame rate = 15fps, Jpeg
Real Time Clock
Tilt sensor
4 Paw sensors
Touch sensors = Head, Nose, Back, left and right flanks
3 color LED eye displays (31 leds each eye)
Voice recognition (100 commands)
Connects to Wlan

RoboSapien

RoboSapien	
Type	Toy robot
Inventor	Mark Tilden
Company	WowWee

RoboSapien is a toy-like biomorphic robot designed by Mark Tilden and produced by WowWee toys. The RoboSapien is preprogrammed with moves, and also can be controlled by an infrared remote control included with the toy, or by either a personal computer equipped with an infrared transmitter, and an infrared transmitter-equipped PDA.

The toy's remote control unit has a total of 21 different buttons. With the help of two shift buttons, a total of 67 different robot-executable commands are accessible.

Overview

The toy is capable of a walking motion without recourse to wheels within its feet. It is also able to grasp objects with either of its hands, and is also able to throw grasped objects with mild force. It has a small loudspeaker unit, which can broadcast several different vocalizations.

User modifications

Mark Tilden designed the RoboSapien to be easily modified or hacked. The electronics inside the toy are easily accessed and clearly labeled. A growing community of hackers have devoted themselves to adding new functionality to the robot. Some hacks have added a live video camera, others an LED belt that displays text, headlights, a coil gun, speech synthesis, a "flamethrower" (a small torch) and more. A modified RoboSapien is also used in the 2009 revival of The Electric Company.

Modified RoboSapiens playing a soccer game.

Other uses

At the German Open 2005 tournament two teams of three RoboSapiens each played the first Soccer match of humanoid robots worldwide. University of Osnabrück played against a team from Albert Ludwig's University of Freiburg. Replacing the head by a PDA allowed the robot to perceive its environment with a camera, a control program could then react to this via the PDA's infrared sender.

Variants

In January 2007, two new Robosapien variants were introduced at the Toy Fair in London, styled after Spider-Man and Homer Simpson, respectively. The Spidersapien features Spider-Man styled armour, and an array of Spider-Man sound effects. It was launched together with *Spider-Man 3*. Homersapien was launched to coincide with the release of *The Simpsons Movie*. He is similarly adapted with sound bites and a sculpted Homer head, as well as a unique Simpsons accessory and packaging. Also Robosapien comes in chrome red,blue,silver,gold,green,and also clear, other than the original white.

Facts

- The dance command plays an instrumental part from the song You Spin Me Round (Like a Record) by Dead or Alive.
- When you turn him off via remote, he mimics the death scene from Citizen Kane (drops snow-globe, says Rosebud).
- You can make him wander around and take karate chops at everything for 5 minutes by using a special button code.

Furby

A **Furby** (plural **Furbys** or **Furbies**) was a popular electronic robotic toy resembling a hamster/owl-like creature which went through a period of being a "must-have" toy following its launch in the holiday season of 1998, with continual sales until 2000. Furbies sold 1.8 million units in 1998, 14 million units in 1999, and altogether in its three years of original production, Furbies sold over 40 million units. Its speaking capabilities were translated into 24 languages.

Furbies were the first successful attempt to produce and sell a domestically-aimed robot. A newly purchased Furby starts out speaking entirely **Furbish**, the unique language that all Furbies use, but are programmed to speak less Furbish as they gradually start using English. English is learned automatically, and no matter what culture they are nurtured in, they learn English. In 2005, new Furbies were released, with voice-recognition and more complex facial movements, andmany other changes and improvements. The Emoto-

Tronic Furbies (Furby, Furby Baby, and Funky Furby) continued to be sold until late 2007, when these toys became extremely rare.

History

Birth of the Furby

Dave Hampton and Caleb Chung spent nine months creating the Furby (in addition to nine months spent designing the toy). Early on, Tiger Electronics showed an interest in their interactive creatures, and Roger Schiffman bought the rights to it. Furby's first public appearance was at the American International Toy Fair in 1998.

Furbies originally retailed for about US$35, and upon release, Furbies flew off the shelves in toyshops. Catapulting demand for these toys during the 1998 holiday season drove the resale price over $100, and sometimes as high as several hundred dollars. Furbies sold for over $300 in newspapers and in auctions. Nicknames were given to them, and sellers assigned rarity values to them. Some people continue to call their Furbies by the terms 'wedding Furby', 'tuxedo Furby', 'snowball Furby', 'biker Furby', among others. All, of course, were dubbed rare by sellers, because they were so hard to find at the time. In a sure display of the demand for the toy, some sellers at scammed people out of a great sum of money, without even having first given them a Furby. Parental battles, arguments, and fights increased rapidly as supplies dwindled, and when retail supplies ran out, parents turned to the Internet, where Furbies could be purchased for two, three, or more multiples of their retail price. During one 12-month period, a total of 27 million Furby toys were sold.

2005 revival

2005 saw the reintroduction of Furby with the release of the new Emoto-Tronic Furby. The increasing emotional realism of the Emoto-Tronic Furby has given birth to a number of Furby-oriented special interest groups. These communities seek to integrate aspects of the Furby experience into human society. The most visible of these groups include Furbish-to-English translators and Furby adoption agencies. In addition, there is a flourishing subculture of Furby Furries.

Furby types

Classic Furbies

An Emoto-Tronic Furby (left) next to a 'Classic' Furby; (right) note the size difference.

The main reason for their popularity was because of apparent "intelligence", reflected in their ability to develop language skills.

Furbies can communicate with one another via an infrared port located between their eyes. Furbies start out speaking entirely *Furbish*, a language with short words, simple syllables, and various other sounds. They are programmed, however, to speak less and less Furbish and more and more English as they "grow".

There was a common misconception that they repeated words that were said around them. This belief most likely stemmed from the fact that it is possible to have the Furby say certain pre-programmed words or phrases more often by petting it whenever it said these words. As a result of this myth, several intelligence agencies banned them from their offices.

A simple electric motor and a system of cams and gears close the Furby's eyes and mouth, raise its ears, and lift it off the ground in a *faux* display of mobility.

The originals are still popular with many hackers as they can be dissected and made to do interesting things. In particular, their advanced audio capabilities and various sensory interfaces make them popular with the circuit bending community.

Other Furbies

Furby Babies

In 1999, the Furby Babies line was introduced. Furby Babies are smaller than the original, have higher voices, and cannot dance, but they switch to speaking English more quickly. They also have an extended vocabulary and different "Easter eggs" and "games" built into them. Furby babies come in 24 different colors. All have white eyelashes and one of six different eyecolors.

Furby Friends

Novel Furbies were also released, including an interactive Furby-like **Gizmo**, from the film Gremlins, a Furby-like **Interactive Yoda** based on the Star Wars character, and a Furby-like **Interactive E.T.** from the movie of the same name. Another 'friend of furby', called **Shelby**, is similar to Furby, but looks like a clam, has vast improvements in memory, and has a different personality; it was released in 2001 and can communicate with the original Furbies and Furby Babies. They also have sensors that can sense loud sounds, can sense being upside down (they say things like "Shiver me timbers" and "Walk the plank" when you leave them upside-down for an extended period of time), and they laugh when you "tickle" them (their antennae - or "tennies", as they like to call them). They also purr when you "pet" them. You can feed them by sticking your finger in their mouth. Similarly, Shelbies do not have their own names, unlike the classic Furbies. Shelbies are also capable of knowing if it is talking to a Furby or another Shelby, saying phrases such as "Where's Furby?"—though they cannot differentiate between a Furby and a Furby Baby—they just assume it is a Furby. In addition to English, Shelbies also know some Furbish words and also have their own unique language called *Shelbish*.

Emoto-Tronic Furbies

The latest species of Furby was released in August 2005. Larger than the previous version, the new Furbies have been upgraded with a more emotional face and a voice recognition system, enabling them to communicate with humans. Unlike the Furbies originally released, just one order is necessary to make them 'sleep', and they have an on/off switch. They can communicate with other Emoto-tronic Furbies, though to a lesser extent than the communication between original Furbies, and they cannot themselves communicate with the original Furbies nor Funky Furbies. They also lack light sensors and basic motion sensors and do not respond to loud sounds as the originals do. These Furbies, according to the story they come packed with, are from Furby Island.

Emoto-Tronic Furby Babies

In 2006, a new version of Furby baby was released, with most notable features being the new look and a more "baby-ish" appearance in contrast to the Emoto-Tronic Furby adult. They also have considerably fewer features than the "adult" Furby, with a very limited

vocabulary and a lower level of interactivity. Another notable feature of the 2006 Emoto-Tronic Baby Furby is the movable "legs" which unfurl when Furby baby is awake.

Emoto-Tronic Funky Furbies

The Funky Furbies were released in August 2006 outside the United States. They are limited to two color combinations (pink & yellow and purple & green) so far, and they can sing three new songs and dance. They can be taught dance routines and remember them.

Furbish-English phrases

Furbish is the language which is spoken by the Furbies. It is similar to English, but with a different grammar structure. A newly purchased Furby starts out speaking entirely **Furbish**, the unique language with short words, simple syllables, and various other sounds, but are programmed to speak less Furbish as they learn more English as they "grow". Throughout a Furby's lifetime, it gradually learns English words and phrases, which it begins to speak in place of Furbish. The more English they learn, the more they "grow", making them more mature. The Furbish phrase "WHOA! Me deep sleep!" would translate into English as "Whoa! I slept for a long time!"

- **wee-tah-kah-loo-loo**: Tell me a joke.
- **wee-tah-kah-wee-loo**: Tell me a story.
- **wee-tee-kah-wah-tee**: Sing me a song.
- **u-nye-loo-lay-doo?**: Do you want to play?
- **u-nye-ay-tay-doo?**: Are you hungry?
- **u-nye-boh-doo?**: How are you?
- **u-nye-way-loh-nee-way**: Go to sleep now.
- **u-nye-noh-lah**: Show me a dance.

Furbies may say these Furbish words:

- **doo?**: What? (Furbies say this when called)
- **doo-dah**: Yes. (Furbies say this in response to a command before doing it.)
- **boo**: No. (Furbies say this when they do not want to carry out a command.)
- **yoo?**: Why will you not play with me today? (This usually means the Furby is upset.)

Chapter- 5

Social Robots

Robots whose main object is social interaction (partner robots) include:

Wakamaru

Wakamaru greeting people

Wakamaru is a Japanese domestic robot made by Mitsubishi Heavy Industries, primarily intended to provide companionship to elderly and disabled people. The robot is yellow, 1m tall, and weighs 30 kilograms. It has two arms and its flat, circular base has a diameter of 45 cm. The first hundred went on sale in September, 2005, for USD $14,000.

Wakamaru runs a Linux operating system on multiple microprocessors. It can connect to the Internet, and has limited speech (in both male and female voices) and speech recognition abilities. Functions include reminding the user to take medicine on time, and calling for help if it suspects something is wrong.

Wakamaru was the childhood name of Minamoto no Yoshitsune. It was named after him.

Paro (robot)

Paro robot seal

Paro is a therapeutic robot baby harp seal, intended to be very cute and to have a calming effect on and elicit emotional responses in patients of hospitals and nursing homes, similar to Animal-Assisted Therapy.

It was designed by Takanori Shibata of the Intelligent System Research Institute of Japan's AIST beginning in 1993. It was first exhibited to the public in late 2001, became a Best of COMDEX finalist in 2003, and handmade versions have been sold commercially since 2004. Paro is based on harp seals Shibata saw in Canada, where he also recorded their cries that Paro uses.

The robot has tactile sensors and responds to petting by moving its tail and opening and closing its eyes. It also responds to sounds and can learn a name. It can show emotions such as surprise, happiness and anger. It produces sounds similar to a real baby seal and (unlike a real baby seal) is active during the day and goes to sleep at night.

PaPeRo

The **PaPeRo** is a personal robot being developed by Japanese firm, NEC Corporation. It is noted for its cute appearance and its facial recognition system. The robot's development began in 1997 with the first prototype, the R100, and adopted the name PaPeRo, which stands for "**Pa**rtner-type-**Pe**rsonal-**Ro**bot" in 2001.

PaPeRo: Personal Robot

PaPeRo has been researched and developed with the intention of its being a partner with human beings and its being able to live together with them. For this reason, it has various basic functions for the purpose of interacting with people.

Since the original introduction of PaPeRo, there have been a few different versions, including a Childcare Version, 2003 and 2005 revised versions, and "PaPe-Jiro", a robotic comedian. In 2006, a virtual PaPeRo was released for use in the PocketPC and any PC running the Windows operating system. Both computer systems can be used to program or monitor the use of the PaPeRo operating system.

In order for PaPeRo to interact with people and perform autonomous actions, the robot itself must understand information on the conditions of and outside the location where it has been put. For this reason, various pieces of equipment have been included to detect the outside area, such as a CCD camera, microphone, ultrasonic sensors, etc.

In the spring of 2009 NEC introduced PaPeRo Mini, weighing half of the current PaPeRo model, and has physical dimensions roughly half the size of the original. The PaPeRo Mini has several enhanced capabilities, and has a small LCD monitor on the front of its chest.

Specifications

Height: 385mm
Width: 248 mm

Depth: 245 mm
Weight: 5.0 kg

Continuous operation time: Approximately 2 to 3 hours
Battery charging time: Approximately 2 to 3 hours
Number of recognizable words: Approximately 3000 (in speaking mode)
Number of speaking words: Approx. 3000

Personalities

PaPeRo is a little helper during the day and can play games with people. In addition, when consulted with questions like "Is today a good day for a date?", or "Is today a good day for a drive?", PaPeRo will connect to the internet, obtain a weather report or information about a person's fortune and then say if today is a "recommended day." Furthermore, if PaPeRo is in a good mood, it will dance to please people.

Basically, PaPeRo has a cheerful character that enjoys speaking with people, but will change depending on the way it interacts with people. Changes in character are expressed by the way it speaks, its vocal quality, its music, and the way it moves. Here are PaPeRo's representative characters.

Leader PaPeRo
This is the character that was developed first. It is easy going and does what it likes. It likes talking with people and is good at imitation and dancing. It dances in accordance to its mood, adapting to the march, which is the theme music for Leader PaPeRo. A cute voice and manner of speaking are special features.

Knowledgeable PaPeRo
Knowledgeable PaPeRo will inform people of various information on the Internet. It will not say what it likes or dislikes, but people can interpret its feelings from its slight gestures. If people speak to it in any way they wish, it will sulk or become naughty. PaPeRo talks in a polite manner using speech synthesis.

Dancing PaPeRo
Dancing PaPeRo is a little bit headstrong, but really likes to dance and is happy if people praise it. It has different theme music than Leader PaPeRo and has a specialty dance that it matches to the music. Using speech syntheses it talks in a friendly tone of voice.

Lazy PaPeRo
If people do not interact with PaPeRo, it will become lazy. If people answer its questions and set it up properly, it will become serious.

Computer PaPeRo
Computer PaPeRo will do what people say, but will not speak to people. If treated affectionately, such as praising it or rubbing it, PaPeRo will move around and talk to people. Like robots in the old days, it will speak in a monotonous voice.

Technology

PaPeRo uses different technologies to interact with its environment. For example, Its "eyes" are really twin cameras with a face recognition system. When PaPeRo has nothing to do, it roams around looking for faces. Upon finding one, it will try to start a conversation. PaPeRo also has a speech recognition system. With a pair of powerful microphones, it can determine exactly where a sound comes from and if the sound is human speech. The robot will then interpret the information and respond accordingly. While PaPeRo roams around, it uses an ultrasound system located in its chest to detect objects. If an object lies in its path, PaPeRo's ultrasound system will detect where exactly the object is, and then PaPeRo will decide what to do to avoid the object. PaPeRo also has sensors located in its head. These sensors can detect if the robot is patted, slapped, etc., with PaPeRo responding accordingly.

PINO

The **Open PINO Platform** (or just **PINO**) is an open humanoid robot platform, with its mechanical and software design covered by the GNU Free Documentation License and GNU General Public License respectively.

The external housing design of the PINO is a proprietary registered design, and the term PINO is trademarked.

The intention of PINO's designers appears to be to create a Linux-like open platform for robotics.

A commercial version of PINO is being sold by ZMP INC. a Tokyo-based robotics company. The latest version is Version 3 (released in August 2006).

EMIEW

EMIEW is a robot developed by Hitachi. Another version has also been made called EMIEW 2. EMIEW stands for **E**xcellent **M**obility and **I**nteractive **E**xistence as **W**orkmate. Two EMIEWs have been made, called Pal and Chum. Hitachi stated that Pal and Chum, have a vocabulary of about 100 words, and Pal exhibited these skills by telling reporters: "I want to be able to walk about in places like Shinjuku and Shibuya in the future without bumping into people and cars". Both EMIEWs have a top speed of 6 km/h (matching ASIMO) and can avoid obstacles.

Specifications

Model	EMIEW	EMIEW 2

Year launched	2005	2007
Mass	70 kg	13 kg
Height	130 cm	80 cm
Maximum speed	6 km/hour	6 km/hour
Acceleration	4 m/s2	4 m/s2
Degrees of Freedom	14 (Arm: 6 degrees of freedom; hand: 1 degree of freedom)	25